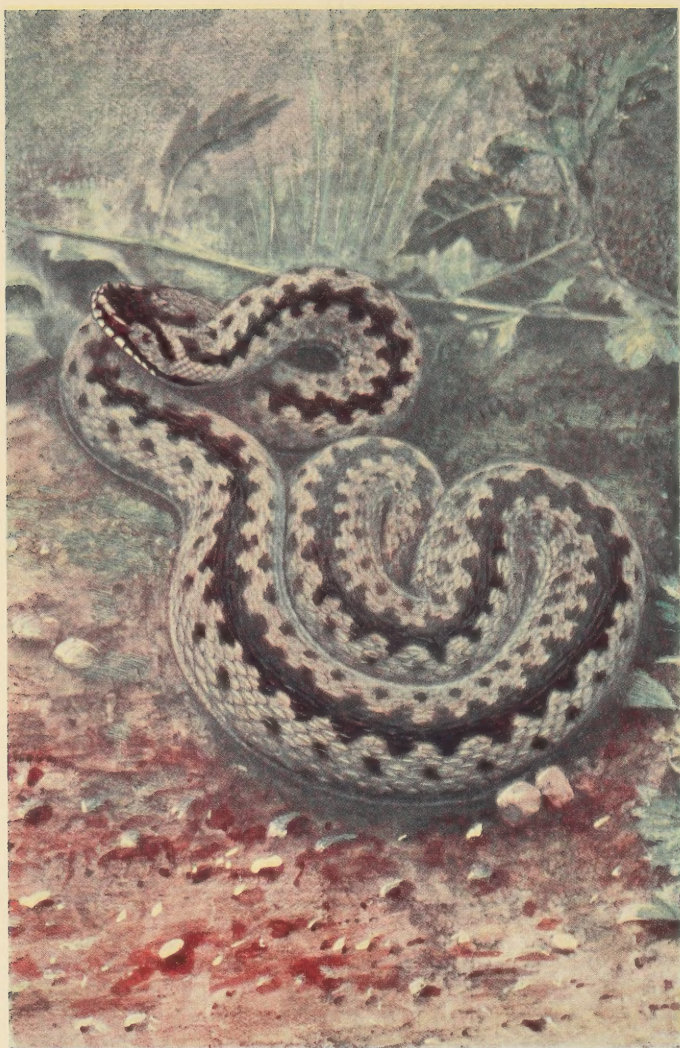






REPTILES AND BATRACHIANS



THE COMMON VIPER

Vipera berus

5
46
277.

REPTILES

AND

BATRACHIANS,

BY
E. G. BOULENGER, F.Z.S.

CURATOR OF LOWER VERTEBRATES
IN THE GARDENS OF THE ZOOLOGICAL SOCIETY



*WITH NUMEROUS
ILLUSTRATIONS*



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PREFACE

IN the following pages an attempt has been made to refer to the classification and systematic position of the animals with which this volume deals, without entering very fully into details, and as much space as possible has been devoted to their life histories and habits.

The numerous photographs which illustrate this book have all been taken by Mr. W. S. Berridge, F.Z.S., mostly from living specimens in the Zoological Gardens, and those who are cognizant of the art of photography will fully appreciate the skill and patience involved in their production.

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E. G. BOULENGER.

*Zoological Society,
Regent's Park,
October 1914.*

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PART I
REPTILES

INTRODUCTION

REPTILES, as well as Batrachians and Fishes, are cold-blooded vertebrate animals, the temperature of their bodies, unlike as in the case of Mammals and Birds, rising and falling according to their surroundings.

From Batrachians, Reptiles differ in breathing by lungs during the whole of their existence, and not by gills as do the former during at least part of their life, and by the fact that the skull, which in Batrachians, as in Mammals, articulates with the vertebral column by two rounded knobs or condyles, is in Reptiles attached as in Birds by a single condyle. Unlike Batrachians, they undergo no metamorphosis, being born in the condition which they will retain for the whole of their life.

In the majority of Reptiles the skin is covered with scales or shields, while in Batrachians it is, with a few exceptions, naked.

The living representatives of the class Reptilia, the majority of which occur in the tropical and semi-tropical parts of the world, are divided up into the following five orders—

- I. The RHYNCHOCEPHALIA:—The TUATERA LIZARD of New Zealand, the survivor of an order of which numerous fossil representatives are known.

II. The CHELONIA :—TURTLES, TERRAPINS, and TORTOISES.

III. The CROCODILIA :—CROCODILES, ALLIGATORS, etc.

IV. The LACERTILIA :—LIZARDS and CHAMELEONS.

V. The OPHIDIA :—SNAKES.

Although in past geological ages Reptiles were the preponderating type of the vertebrates, at the present day there are in all but 4000 different species, a very low number when compared to Fishes and Birds, the representatives of which each number over 10,000.

CHAPTER I

THE RHYNCHOCEPHALIA

Sphenodon punctatus, the Tuatera Lizard of the Maoris, is, as mentioned in the Introduction, the only living member of a group of Reptiles otherwise known from fossil representatives only, and there can be no doubt as to its being the oldest living reptilian type. In spite of its lizard-like form it is perhaps almost as closely related to the Tortoises as to the Lizards, and in fact many authorities regard the order into which this creature falls as having directly given rise to the Tortoises and the Crocodiles. Externally the Tuatera resembles those lizards known as Agamas and Iguanas, and was in fact originally referred to the former of these families. It differs, however, from true lizards in many anatomical features, the principal of these residing in the fact that the temporal region is bridged over by two bony arches, the lower of which is absent in lizards, and that, in addition to the sternal apparatus, a supplementary system of numerous bones, so-called "abdominal ribs," foreshadows the plastron of Chelonians. A feature of *Sphenodon* is its possession of the vestigial structure known as the "pineal eye," an apparently functionless organ situated on the top of the head, believed to represent the remains of a once functional eye.

The body is stoutly built, being only slightly compressed on the sides; it possesses a series of spine-like lobes extending, but for a small interruption on the nape, from behind the head to the end of the tail. The latter organ, which is comparatively short, is very thick and somewhat compressed, and is capable of regeneration as in lizards.

The limbs are well-developed, the fore limbs being a little shorter than the hind ones; the digits, five in number on both hand and foot, are webbed at the base and

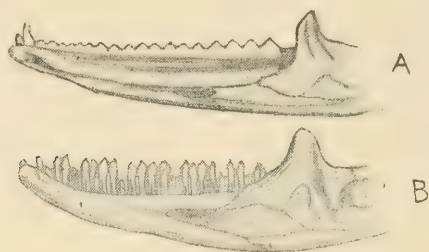


FIG. 1.—Lower jaws, showing the acrodont dentition (a), and pleurodont dentition (b).

(From B. M. Guide to Reptile Gallery.)

provided with strong claws; the eye is rather large, brown in colour, with a vertical pupil; the tongue is short, thick and not very protrusible; the nostrils are small and lateral; the ear is absent, as in snakes; the teeth, which seem to form part of the jaw itself, so completely are their bases fused with the bone, belong to the so-called *acrodont* type, being inserted on the edge of the jaw, in opposition to the dentition known as *pleurodont*, in which they are applied to the inner side; those in front are incisor-like and form a sort of beak, whence the name *Rhynchocephalia*. The scales on the upper parts are granular, intermixed with

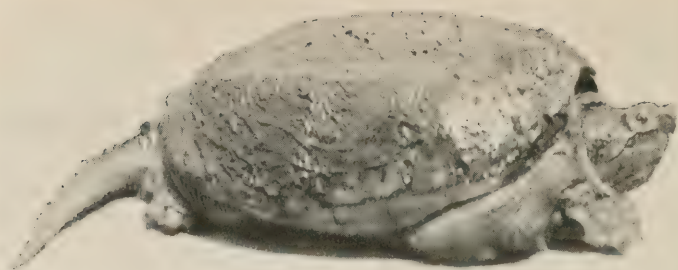


Tuatera Lizard, *Sphenodon punctatus*.



Skulls of *Sphenodon* and Lizard (*Uromastix*).

(a)



(b)



(c)



- (a) Snapping Turtle, *Chelydra serpentina*.
(b) Three-keeled Terrapin, *Staurotypus triporcatus*.
(c) Maw's Terrapin, *Dermatemys mawii*.

small scattered tubercles ; those on the ventral surface are large and squarish, and arranged in transverse series.

The colour is usually olive-grey with a few yellow dots ; in a few cases it is nearly black ; the lobes of the dorsal crest are whitish or yellowish. The males are no brighter than the females, and have no other secondary sexual characters than a somewhat bigger head, a higher dorsal crest, and a somewhat larger size.

Until fairly recently, *Sphenodon* was quite abundant in many parts of South Island, but on the larger islands it is now all but extinct, its extermination being due to colonization and the advent of domestic and commensal animals such as pigs and rats ; it is now only to be found in the smaller islands of the Bay of Plenty, where, after having been much hunted for by zoological collectors and dealers, it now fortunately enjoys Government protection. A good illustration of the rapid extermination of this creature lies in the fact that whereas twenty-five years ago a living specimen could be purchased from almost any dealer for twenty to thirty shillings, at the present time about fifteen pounds represents its market value.

The Tuatera lives in deep holes, which it generally digs out itself, and in which it sleeps during the day, coming out in search of food at dusk. These holes it often shares with various kinds of Petrels, the Tuatera and the Petrel building their nests separately, the former almost invariably taking the right side of the chamber and the latter the left. The chambers measure about two feet in length, one foot in width, and six inches in depth, the entrance being only about four inches in diameter. The creature always lies in such a position that its head faces the entrance to the

chamber, ready to defend its home from intruders, biting and making use of its claws for the purpose. According to A. Reischek, who has made numerous observations on the natural history of Chicken Island, and has devoted much attention to the habits of the Tuatera, it is not uncommon to find two petrels inhabiting one side, but never two tuateras sharing the same chamber. This observer is of the opinion that in a few instances the holes are dug out by the birds, the two habitations being distinguishable through the fact that the birds dig in solid and hard earth, while the reptiles only excavate where the soil is soft and loose.

The Tuatera is oviparous, laying from eight to a dozen tough but not hard-shelled white eggs, nearly an inch in length, in the months of December and January. These take an extraordinary long time to hatch, the young only appearing about thirteen months after the egg has been laid.

In captivity, although they do well, Tuateras are rather dull and uninteresting, as most of the day is spent in the retreat provided for them, or in the holes they burrow; the latter are usually dug out at dusk, the creatures making use of their long claws for this operation. They are first-class swimmers, and, therefore, a large tank of water should be provided for bathing purposes.

Their favourite food consists of earthworms, slugs, frogs, and small lizards. Contrary to the experience of Dr. Gadow, who kept numbers for many years, those at the Zoological Gardens were all fond of meat. Mice were also regarded by them as a delicacy. These specimens were always silent, although other individuals have been known to utter, especially at dusk, sounds somewhat resembling the

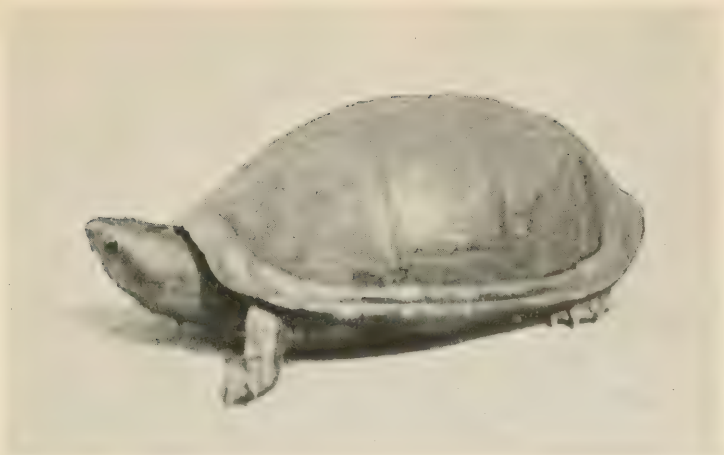
croaking of a frog. Very few specimens ever become at all tame, and they can never be handled without the risk of a rather painful bite, for although their teeth are not particularly sharp, their jaws are endowed with very great muscular power.

CHAPTER II

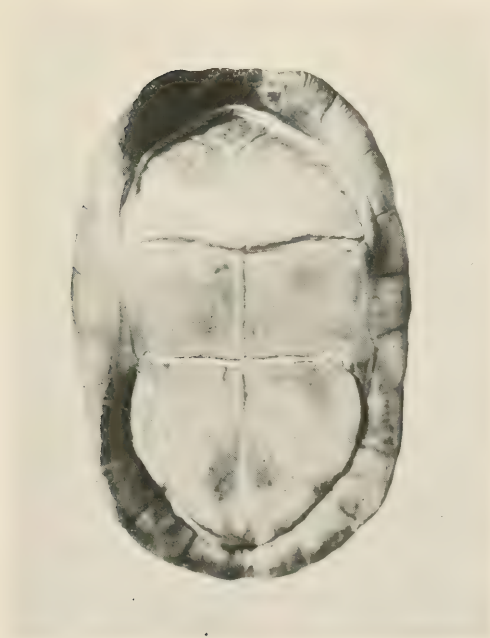
CHELONIA—TURTLES, TERRAPINS, AND TORTOISES

THE members of this order may be entirely aquatic, only partly so, or entirely terrestrial, with paddle-shaped limbs in the case of the first, with club-shaped limbs in the case of the last, and intermediate in structure in the second category. In this book the forms living entirely on land are designated under the name of Tortoises, those living both on land and in water as Terrapins, and the exclusively aquatic forms as Turtles; the last mentioned are further divisible into fresh-water and marine.

The body of these animals is protected by a bony shell, usually covered with horny shields, into which the head, neck, limbs, and tail may be retracted. This shell is composed of numerous bones, the principal being expansions of the vertebræ and ribs, forming the carapace, or dorsal buckler, the neck and tail being the only movable portions of the spinal column, and clavicles and abdominal bones forming the plastron or ventral buckler. The carapace and plastron are usually connected by a lateral part known as the bridge. Both the bony plates and the horny shields on the shell afford excellent characters for the purpose of classification, but as the shields only are

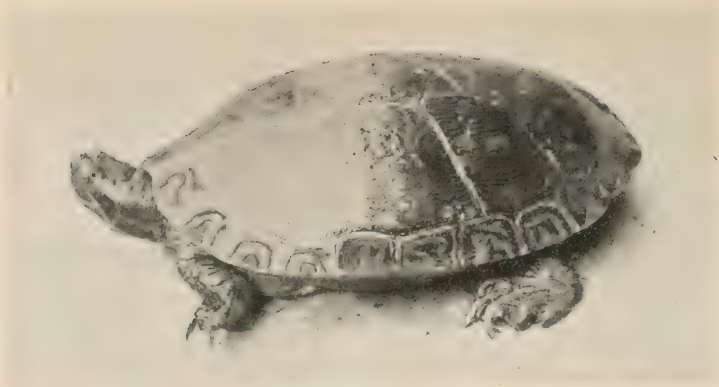


Mud Terrapin, *Cinosternum cruentatum*.

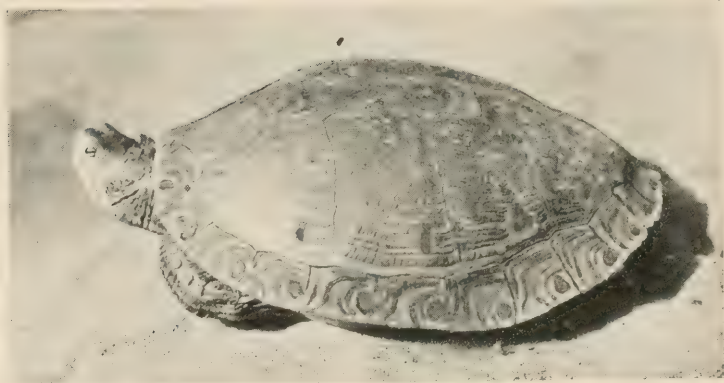


Plastron of *Cinosternum cruentatum*,
showing hinges.

(a)



(b)



(c)



(a) Painted Terrapin, *Chrysemys picta*.
(b) Adorned Terrapin, *Chrysemys ornata*.
(c) European Pond Terrapin, *Emys orbicularis*.

available for examination in the case of living specimens, we shall confine ourselves to the disposition and nomenclature of the latter, for which the reader is referred to fig. 2.

In some tortoises and terrapins perfect hinges of elastic

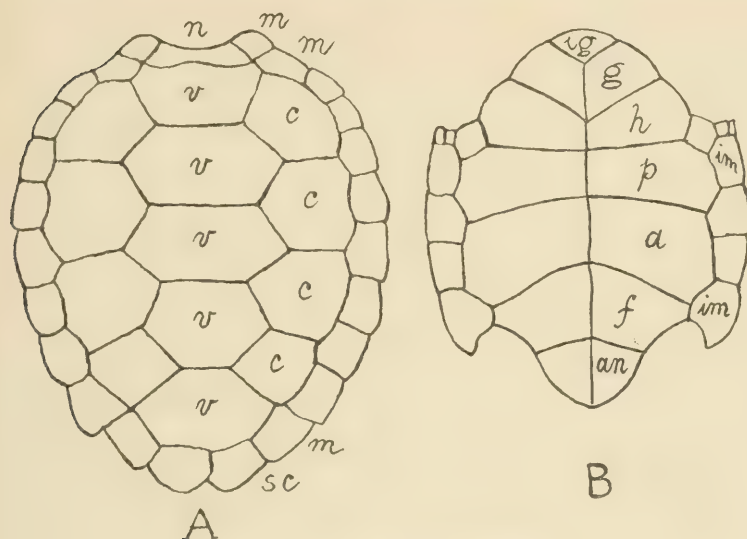


FIG. 2.—Shell of *Chelone mydas*.

A. Carapace.

- a. Abdominal.
an. Anal.
c. Costal.
f. Femoral.
g. Gular.

- h. Humeral.
ig. Intergular.
im. Inframarginal.
m. Marginal.

B. Plastron.

- n. Nuchal.
p. Pectoral.
sc. Supracaudal.
v. Vertebral.

(After Boulenger.)

ligament are formed across the plastron, as in the so-called Box Tortoises, and either the anterior or the posterior lobes, or both, as the case may be, are movable and close up the shell. In the genus *Cinixys* a similar hinge is situated across the carapace, the hinder part of which is movable.

Regeneration of lost parts does not take place, although, as Gadow has shown, the injuries to the shell are made good by new growth of bony and horny tissue, after the necrotic portion has been cast off.

A tail is always present, but differs much both in length and structure, according to genera and species, this organ being sometimes covered with horny or bony tubercles, while in many the tip is provided with a sharp, nail-like spur. The toothless jaws are covered with cutting horny sheaths, which may be serrated and constitute false teeth. The neck, which varies much in length, may be either completely or only partly withdrawn into the shell, in some forms simply sideways (*Pleurodira*), or by a sigmoid curve in a vertical plane (*Cryptodira*). The eye is rather small and protected by an upper and a lower lid, and a transparent membrane (the nictitating membrane), which moves horizontally; the pupil is always round. The sight and senses of taste and touch are well developed, that of hearing, however, is very imperfect, especially among aquatic forms, some of which are devoid of an exposed tympanum or ear-drum.

All tortoises, terrapins, and turtles are oviparous, laying eggs which may be round, oval, or elliptical, and as a rule hard-shelled: marine turtles, however, produce eggs, the shell of which is imperfectly calcified: they are invariably buried in the ground and hatched by the heat of the sun. Hibernation takes place in the temperate zones, the period varying in length according to the climate. Aquatic species do so generally at the bottom of the ponds or rivers they live in, or in the mud on the banks, while the land forms secrete themselves in the earth and sand, a

few constructing regular burrows which may extend to a depth of several feet.

The food varies according to the structure and the mode of life. Land forms are vegetarians, those frequenting the water are either carnivorous or herbivorous, a few only living on a mixed diet.

Tortoises are remarkably long-lived, the giant forms of the Aldabra and Galapagos Islands attaining an age unparalleled by any other animal.

The order is not a very large one, the number of species of Chelonians amounting to only just over 200.

Sub-order ATHECÆ :—Vertebræ and ribs free, within the carapace.

The LEATHERY TURTLE, *Dermochelys coriacea*, of the family SPHARGIDÆ, is the only representative of the sub-order. It is the largest of living chelonians, and differs from all other turtles, terrapins, and tortoises in its vertebræ and ribs being entirely free, and not fused with the carapace. The body is protected by a shield of small mosaic-like bony plates, covered with a very thick layer of leathery skin, which, except for the presence of a number of longitudinal ridges, is in adult specimens perfectly smooth; in the young it appears rather tuberculate. The limbs are paddle-shaped flippers, devoid of claws, giving the creature great swimming powers, and enabling it to venture far out to sea. In colour it is dark brown, often more or less distinctly spotted with yellow, or as if splashed with whitewash.

This creature has been considered to represent, so far as its vertebral column is concerned, the primitive type

out of which the ordinary tortoise has been evolved, it being believed that the ossifications underlying the skin have gradually become fused with the bones of the skeleton to form the shell of tortoises and turtles proper. Others believe the *Sphargidæ* to represent an ultra-specialized type evolved out of the turtles.

The Leathery Turtle has a world-wide distribution, and is, in fact, a pelagic animal, straying to very distant localities, occasionally visiting the coast of Great Britain. In spite of its wide range it is by no means common. Numbers have been seen, however, off the coast of Tenasserim, and at the entrance to the Klang Straits, where they congregate in order to deposit their eggs, each female depositing some three or four hundred.

The strength of the creature may be fully realized by the following interesting account, which has been given by G. W. Gourley, of the capture of a specimen at Santa Barbara in the year 1905.

“The turtle was first seen swimming on the surface about two miles off shore. I went after it, accompanied by a boy, in an eighteen-foot sailing boat. On approaching the turtle I dropped the tiller and got forward with the gaff hook, swung over the side, and got the hook fast in the leathery part of his neck. He immediately sounded, and ran out the full length of the line—about two hundred feet—towing the boat about half a mile further out to sea. He then came to the surface and we pulled up close to him again. When he caught sight of the boat he turned and came towards us and threw his flippers over the gunwale of the boat, nearly capsizing her. I climbed up on the upper side, and shoved him off with an oar, the end

of which he grabbed and bit off like a piece of cheese. His movements were very swift; using his fore-flipper he could turn almost instantly from one side to the other, and his head would project about eighteen inches from the body. I succeeded at last in throwing a noose over his head, and later, by attracting his attention in the opposite direction, got ropes round both flippers, finally having five lines on him, and started to tow him towards the shore. We were from 11.30 a.m. until 4 p.m. in finally landing him. When about half-way to shore he suddenly turned, and made a break out to sea, towing the boat stern first, with all sail drawing full, for several hundred yards, with little effort. He emitted at intervals a noise somewhat resembling the grunt of a wild boar."

The largest specimen on record is over eight feet in length and weighs just over 1,500 pounds.

Sub-order THECOPHORA :—Dorsal vertebræ and ribs united to form the carapace.

The sub-order is divided into two super-families, namely, the CRYPTODIRA, in which the neck bends in an S-shaped curve in a vertical plane, and the PLEURODIRA, in which it bends merely sideways.

Some of the most curious members of the CRYPTODIRA belong to the family CHELYDRIDÆ, which is represented by three genera and four species, namely, by *Chelydra serpentina*, *Chelydra rossignoni*, and *Macrochelys temminckii* in America, and by *Devisia mythodes* recently discovered in New Guinea.

These turtles, known as SNAPPING TURTLES or ALLIGATOR TURTLES, are characterized by an enormous head, a

thick neck, strongly hooked jaws, a long tail, a chin provided with fleshy appendages, and a very small cross-shaped plastron. *Chelydra serpentina* reaches a total length of about three feet, *Macrolemmys* to almost twice that size. The tail accounts for more than a quarter of the total length. The colour in all species is dull olive above, yellow inferiorly.

Chelydra serpentina is distributed throughout the United States and extends into Mexico, while *Macrolemmys*, although occasionally found in the Southern States, is most abundant in the Mississippi and its tributaries. The second species of *Chelydra*, *Ch. rossignoni*, which is rather rare, is found in Central America and Ecuador.

In *Macrolemmys* a number of white fleshy appendages of the mucous membrane are situated just in front of the tongue, which, the mouth of the creature being kept open, when in the water, are moved in such a manner as to simulate living worms, with the evident object of attracting the fish it lives on.

All these turtles are notorious on account of their savage dispositions. When annoyed they elevate themselves on their hind limbs and turn almost complete somersaults in their efforts to bite. According to Holbrook they live at the bottom of stagnant pools or rivers of sluggish motion, occasionally coming to the surface with the tip of their snouts elevated, the other parts concealed, and in this manner float about aimlessly, descending to the bottom again when disturbed. They are occasionally said to leave the rivers and to roam about on land, some distance from the water. They are much esteemed as an article of food, and large quantities, at least in North

America, are brought to market. They do exceedingly well in captivity, two "Snappers" in the collection of the Zoological Society, received nearly fourteen years ago, are almost as ferocious as on arrival, and will still occasionally seize upon walking-sticks and such articles as may be offered them for the purpose of inducing them to show off their uncontrollable tempers. These specimens are fed exclusively on meat. In their native land they feed principally on fish and small waterfowl.

The turtles of the family DERMATEMYDÆ, which includes three genera, *Dermatemys*, *Staurotypus*, and *Claudius*, all represented by a single species, are restricted to Central America. But for the PLATYSTERNIDÆ, characterized by a very long tail, and the Marine Turtles, the possession of a series of shields on the bridge separates this family from all others.

Maw's Turtle, *Dermatemys mawi*, which grows to a very large size, the shell alone often exceeding two feet in length, lives in the running waters of Honduras, where it forms an important article of food for the colonists. It feeds exclusively on vegetable matter. The plastron of this turtle, unlike that of the other two genera, is large and not cross-shaped.

The Three-Keeled Turtle, *Staurotypus triporcatus*, is characterized by three very pronounced keels on the carapace. The plastron is remarkably small and cruciform, as in the Snapping Turtles, which, but for the extremely short tail, it resembles in general appearance, and also in being of a similarly fierce disposition.

In the family CINOSTERNIDÆ, popularly known as MUD

TERRAPINS, the anterior and posterior lobes of the plastron are movable and connected with the central part by hinges, so that their oval-shaped shell can be partly or completely closed. The mobility of the plastron varies considerably according to species and with age, for, as in the case of all Terrapins with hinged plastrons, the mobility is not so marked in the young. The species most frequently seen in captivity are the PENNSYLVANIAN MUD TERRAPIN, *C. pennsylvanicum*; the STINK-POT MUD TERRAPIN, *C. odoratum*; and the BLOOD-STAINED MUD TERRAPIN, *C. cruentatum*. The two former are distributed throughout the Eastern States of North America, while the latter is confined to Central America.

In *C. pennsylvanicum* and *C. cruentatum* the plastral lobes are freely movable; the plastron, however, in the former species, is small, and consequently does not close up completely against the rim of the carapace, as in the case of the latter. The end of the tail is provided with a horny, nail-like appendage in both sexes in *C. pennsylvanicum*, it is present only in the female in *C. cruentatum*, and is absent in both sexes in *C. odoratum*. In the latter species the plastron is considerably narrower and smaller than in the two preceding, and the lobes are only feebly movable. This terrapin derives its name from the fact that on being alarmed it emits from certain glands a remarkably pungent and most disagreeable odour of musk.

The members of this family, none of which exceed a shell length of six inches, are found in muddy ponds or ditches, feeding on small fish and tadpoles. They are very treacherous creatures; when handled they immediately withdraw into their shells, firmly closing them; they

do not remain inside for long, however, for after a few seconds they dart out with unexpected rapidity, their mouths wide open, ready to inflict a severe bite with their cutting jaws. The back of the legs of the males in some of the species bears two patches of horny tubercles, and by rubbing these against one another stridulating sounds are produced very similar to those so well known in grasshoppers.

The widely distributed family TESTUDINIDÆ, which embraces some 130 species, includes a number of strictly aquatic genera, as well as all the land tortoises, the passage from the one form to the other being so gradual as to preclude any sharp definition. With the exception of Australia and Papuasia its representatives are distributed throughout the greater part of the world.

Batagur and *Hardella* are two closely related aquatic genera, represented each by a single species; the former, inhabiting Bengal, Burma, Siam, and the Malay Peninsula, is to be distinguished from the latter, which is confined to Northern India, by its front limbs being provided with only four claws, instead of the usual five. The limbs are very broadly webbed, somewhat approaching the paddle-shape. The tail is short.

The BASKA TURTLE, *Batagur baska*, abounds in the Ganges and its tributaries, and is occasionally caught out at sea in fishing nets. Although purely a vegetable feeder in its native waters, specimens in our Zoological Gardens all develop a taste for the bread, biscuits, and buns thrown into their tank by visitors. The eggs of this species, the collecting of which is a royal prerogative

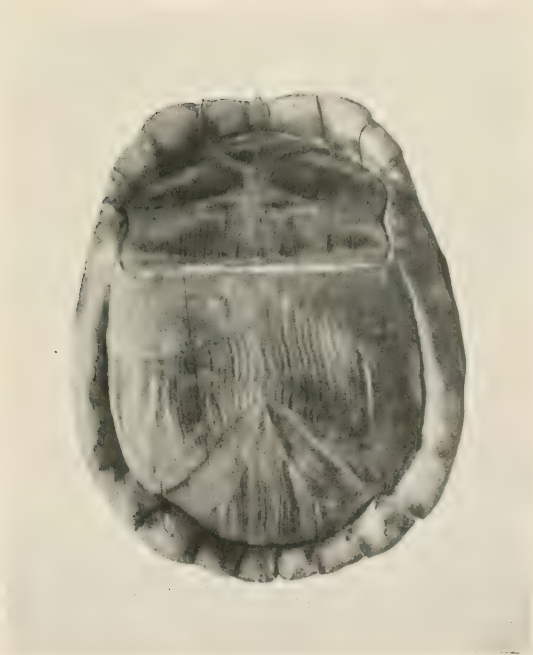
in Siam, resemble both in size and shape those of a domestic fowl.

Hardella thurgi, which likewise feeds solely on aquatic plants, is, according to Anderson, brought to Calcutta in large numbers during the cold months and sold to a low caste of Hindoos, who keep them alive in tanks, selling and eating them themselves. He gives the following account of the extraordinary manner in which they are captured : " A number of men, all but naked, collect together, each man being provided with a large bundle of green marsh grass neatly tied up in the form of a cylinder, measuring about two feet long. These men enter the water, throwing the bundles before them, which act as floats, and on which each man rests his chest as he gets beyond his depth. Then, one after another, they push away these floats, dive to the bottom of the river, and reappear generally with an example of *Hardella* obtained in the mud."

Chrysemys is a large genus distributed throughout North and Central America. The carapace is feebly convex, the plastron is immovable. Although eminently aquatic, frequenting rivers and ponds, and ditches in the case of *C. picta*, these terrapins often leave the water, and are most active on land. The soft parts as well as the shields are in most species most beautifully marked. In *C. ornata*, for instance, the head and neck are streaked with orange, while each costal and marginal shield is provided with a large yellow or orange ocellar spot. These markings are brighter and much better defined in the young than in the adult, where, in a good many cases, they disappear almost entirely. In *C. scripta* the sides of the head are ornamented with bright yellow, or yellow and pink bands.



Box Tortoise, *Cistudo carolina*.



Plastron of *Cistudo carolina*, showing hinges.



The Eroded *Cinixys*, *Cinixys erosa*.

Mr. Hugh Smith has given an interesting account of the breeding habits of this species. The egg-laying season, it appears, is in June and July, and the eggs are laid in some cultivated tract, usually a cornfield adjoining water, the nests being made some distance away from the water, sometimes more than a hundred feet. The nest, which is shaped like a bottle, is made usually in a sandy clay, above high-water mark, the hole being dug out by the female with her fore-legs. The size of the nest depends on the size of the animal, an average nest being four inches deep and four inches wide. The eggs, up to thirty-five in number, are laid at one time, and when the laying is completed, earth is scraped into and over the hole and packed lightly. The packing is accomplished by the terrapin raising herself as high as possible on her hind legs, and then dropping heavily. As soon as the nest is covered over the terrapin withdraws to the water. If a terrapin is disturbed while making a nest or laying, she will abandon the nest. The young hatch in the autumn, but remain in the nest, where they hibernate until the following spring. On emerging they are about the size of a two-shilling piece. This terrapin formerly supported a profitable fishing industry, but of late years has become rather scarce, those caught being accidentally taken in fishing nets.

The PAINTED TERRAPIN, *C. picta*, is perhaps the most attractive representative of the genus. The carapace is dark olive or blackish, with often a yellow vertebral stripe, while the marginal shields are scarlet; the yellow bands of the neck usually form three forks, one in the middle, with the base on the chin, and one on each side, the upper

branch of which extends to the eye. These terrapins, especially the young, make most attractive pets, becoming very tame; care, however, has to be taken in the handling of freshly captured specimens, for they are occasionally disposed to bite. Their food is said to consist chiefly of small fish and tadpoles; in captivity, however, they may be fed exclusively on insects and meat; some individuals are herbivorous as well.

In *Emys* the plastron, which is large and united to the carapace by ligament, is divided in the adult into two lobes, more or less movable upon a middle transverse hinge. The head is covered with smooth, undivided skin. The limbs, which are extensively webbed, are provided with long claws.

The genus is represented by two species only, the range being restricted to the temperate parts of the northern hemisphere. In prehistoric days its distribution was more extensive, *Emys orbicularis* being found in England and other parts of Northern Europe, from which it is now absent.

Its members are more or less aquatic, passing most of their existence in the water, occasionally taking to land to bask in the sun.

The EUROPEAN POND TORTOISE, *Emys orbicularis*, is distributed throughout the greater part of Southern Europe, Algeria, Tunisia, and South-West Asia. In Central Europe it extends locally as far north as Central France, Holland, Prussia, and Poland. The coloration of the shell is subject to much variation; it is usually dark brown or black with numerous yellow radiating lines, or spots; the plastron is yellow and brown, occasionally entirely

blackish brown. The head is black, with lighter dots, which are usually yellow, and in some males of a pale brown. The shell, which is oval in the adult, round in the young, is smooth, with a few well-marked ridges on each shield. The tail is as long as the shell in the quite young, two-thirds that length in adult males, and about one half in the females.

This tortoise generally hibernates in the mud at the bottom of the pond or river towards the end of October. The lethargy, especially of those hibernating in shallow waters, is not very profound, and a little sunshine, even in mid-winter, is sufficient to awaken them from their slumbers. They resume their activity towards the middle of March, pairing in April, and depositing up to a dozen oblong eggs in May and June. Adult specimens do well in captivity; they feed both on land and in the water, usually only upon meat or fish; I have known specimens, however, to accept lettuce. The quite young, of which such large numbers are annually imported and sold in this country, are, however, exceedingly delicate, and generally succumb to pneumonia after a very few months of captivity. The flesh of this species is said to be moderately good eating, and was formerly appreciated as a delicacy for "fish days" in the Roman Catholic parts of Germany.

BLANDING'S TERRAPIN, *Emys blandingi*, is a North American species, closely resembling the European Pond Terrapin. The carapace, which is slightly more convex than in the latter species, is jet black, spotted with bright yellow. The plastron is yellow and black. The head is brown above, yellow beneath. Like its European ally it is easily domesticated. It takes to land frequently in

search of a change of diet, feeding on insects and berries.

In *Clemmys* the plastron is united to the carapace by bone and not by ligament as in *Emys*, from which it does not otherwise differ. The genus is represented in Europe, Africa, South-Western Asia, China, Japan, and North America. Two species are found in Europe, the Iberian Terrapin, *Cl. leprosa*, which inhabits the Spanish Peninsula, Morocco, Algeria, and Tunisia, and the Caspian Terrapin, *Cl. caspica*, restricted to South-Eastern Europe and Asia, from the borders of the Caspian Sea to the Persian Gulf.

In *Cl. leprosa* the carapace is dark olive; the plastron yellow. The head is olive, the sides being streaked with yellow, while an orange spot is situated between the orbit and the ear. A number of yellow bands extend along each side of the neck. The shell seldom exceeds six inches in length. Its specific name is derived from the fact that the creature is subject to a gangrenous disease, when living in not sufficiently aerated waters, which gives the shell a leprous appearance.

Cl. caspica is more handsome, the carapace being elegantly marked with black-edged yellow, wavy markings. This and the preceding species are far more aquatic in their habits than *Emys orbicularis*, and, unlike the latter terrapin, never feed out of water. Freshly captured specimens of the Caspian Terrapin emit, when handled, a disagreeable odour, which is due, as in *Cinosternum*, to the secretion of a pair of inguinal glands. When kept for some time in confinement, however, they lose this objectionable habit. Although reaching a length of about

five inches, imported specimens rarely measure more than two, and, like most quite young terrapins, seldom thrive for any considerable time under captive conditions.

The SCULPTURED TERRAPIN, *Cl. insculpta*, and the SPECKLED TERRAPIN, *Cl. guttata*, are two common North American species. The carapace of both is blackish, that of the former with radiating lines, the latter with numerous perfectly round yellow spots. They are both much more terrestrial in their habits than the European species, wandering many miles from the water, and during the period of spring fires large numbers are burned in the woods. *Cl. insculpta* is herbivorous, feeding mainly on sorrel and berries, while *Cl. guttata* is mainly insectivorous.

In *Cistudo*, the representatives of which are the true Box Tortoises, the plastron is connected with the carapace simply by ligament, and is divided into two movable lobes, enabling the creature, after withdrawing its head, neck, limbs, and tail into the shell, to close it hermetically like a box. The digits are almost entirely free, being provided, at most, with only a very short web.

The COMMON BOX TORTOISE, *Cistudo carolina*, is found in the United States and Mexico. The shell is very convex and nearly round in shape. The tail is quite short. The head is small, and the upper jaw is strongly, the lower jaw feebly, hooked. The variation in colour is very great, no two specimens being quite alike. The most normal coloration of the shell is yellow, with dark brown markings, disposed without any symmetry. The plastron also varies considerably; it is usually yellow with black or brown blotches. The Box Tortoise, although closely related to the aquatic forms by the structure of its feet,

seldom enters the water, but, on the contrary, frequents very dry places, such as the pine forests of the Southern States, where it is particularly abundant. Wild and freshly captured specimens are usually very shy, retreating into their shells, when approached, firmly closing them, and refusing to come out until they fancy all danger has disappeared. They take kindly to captivity, however, and often become so tame that they cannot be induced to close their shells. Their diet is a mixed one, consisting of vegetables, small frogs, and earth-worms, the latter especially being highly appreciated.

With the genus *Cinixys* begins the series of entirely terrestrial types—the true tortoises, which are provided with club-shaped feet and webless digits, and in which the plastron is always united to the carapace by a broad bridge.

In this genus a remarkable modification of the shell takes place, the posterior portion of the dorsal buckler being hinged and movable.

The ERODED CINIXYS, *Cinixys erosa*, is a curious form from Western Africa. The anterior and posterior margins of the carapace are serrated and strongly reverted, especially in the young, while the plastron is forked in front, and projects considerably beyond the anterior border of the carapace, giving the creature a somewhat grotesque appearance; the length of this projection equals about one-fifth the total length of the plastron in the female, and somewhat more in the male. These tortoises are abnormally shy and stupid, and of the numerous specimens which I have had from time to time, none have ever become at all tame, but when approached hiss loudly,

withdrawing immediately into their shells. Large specimens measure about a foot in length.

Testudo, the most comprehensive genus of the order, is represented by some fifty species, all terrestrial forms, and includes the three kinds of European Land Tortoises, namely, the Iberian Tortoise, the Greek Tortoise, and the Margined Tortoise.

THE IBERIAN TORTOISE, *T. iberica*, which is so commonly kept in captivity in this country, is found in North Africa, from Morocco to Tunisia, in Southern Spain, Turkey, Roumania, and South-West Asia. The shell is usually pale, dirty yellow, sometimes brown, with a number of black blotches. A diagnostic point distinguishing it from the other two European species, lies in the presence of a large, conical, bony tubercle, covered by a horny sheath, situated on the back of the thigh. Adult specimens may attain nine inches in length. Although the maximum age that this species may attain is quite unknown, many have been kept in captivity for very lengthy periods. Gilbert White's famous tortoise, which belonged to this species, lived nearly sixty years, while a specimen that died only last year, belonging to Miss Jenkins, of Trevergie, in Cornwall, had been kept in the family for ninety-six years. Only a year before its death its owner wrote that in the hot weather the creature would pursue the gardener with such determination, biting his trousers, and butting at his feet, that he was unable to get on with his work, until it had been shut up in the house.

THE GREEK TORTOISE, *T. græca*, restricted to the Balearic Islands, Sicily, Corsica, Sardinia, the Balkan Peninsula, the Greek Archipelago, and Syria, is often

confounded with *T. ibera*, which it greatly resembles, but from which it may easily be distinguished by the absence of the tubercle at the back of the thigh, and by the supracaudal shield being divided into two, instead of single; the shell is also of a brighter yellow, and the black markings are more sharply defined.

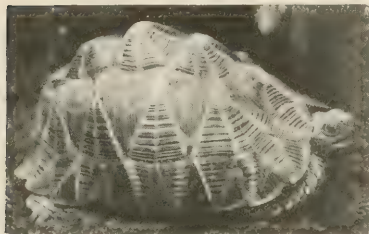
The MARGINED TORTOISE, *T. marginata*, is confined to Greece and Sardinia. It has an elongated shell, the posterior margin of which is strongly expanded, and more or less serrated. Black or dark brown is the ground colour of the carapace, each shield bearing a yellow spot. The plastron is yellow, with black blotches.

The habits of the three European species do not differ; their pairing season begins in April or May, and lasts throughout the summer. At this period the male becomes very active and excitable, and goes through various antics, repeatedly knocking his shell against that of the female, the latter scratching a hole in the ground, in which she lays three or four hard-shelled, shortly oblong eggs. Adult specimens do well in this climate if given the run of a garden, feeding mainly on grass and dandelion leaves; they hibernate towards the beginning of October, burying themselves a foot or so into the ground, reappearing the following spring.

The STARRED TORTOISE, *T. elegans*, is a very common species in India and Ceylon, but is not frequently seen in captivity, as difficulty, it appears, is experienced in procuring specimens, owing to the fact that the colour blends to a great extent with the rocky nature of the ground upon which it is found. The shell, which measures up to eight inches in length, is very high, with the



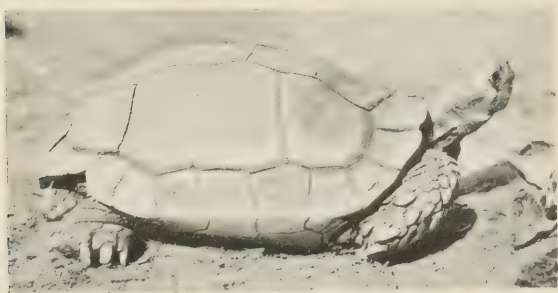
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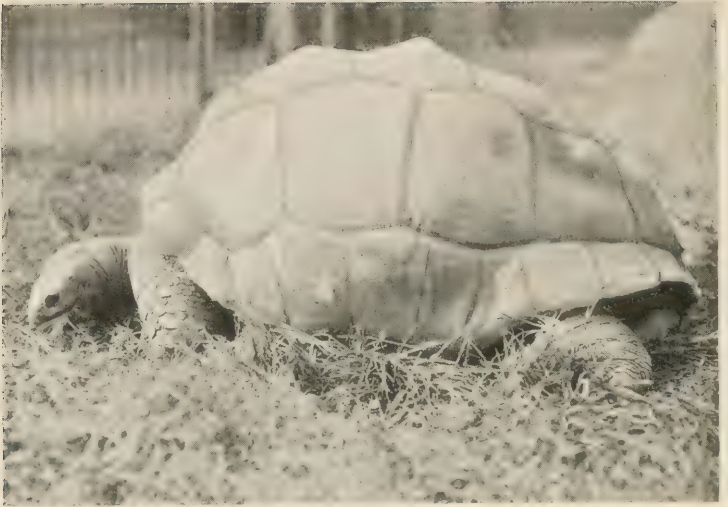
(d)

(a) Algerian Tortoise, *Testudo ibera*.

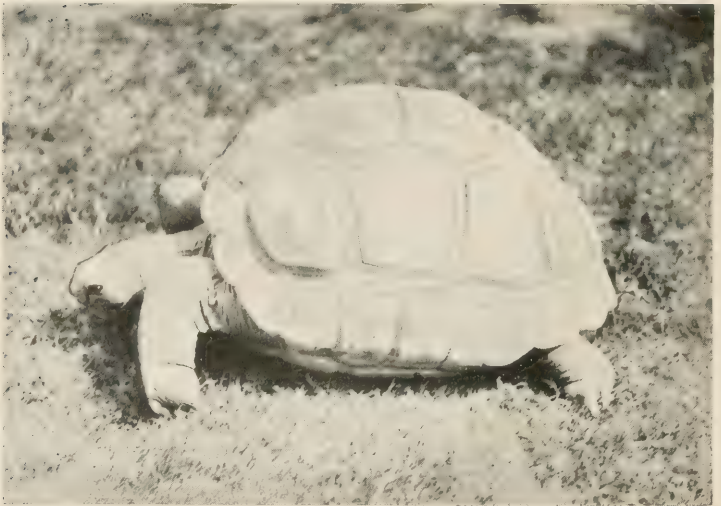
(b) The Star Tortoise, *Testudo elegans*.

(c) The South American Tortoise, *Testudo tabulata*.

(d) Phayre's Tortoise, *Testudo emys*.



The Elephant Tortoise, *Testudo elephantina*.



The South Albemarle Tortoise, *Testudo vicina*.

lateral margins almost vertical. The ground colour is black, from which numerous yellow lines radiate. The plastron is likewise black, with yellow radiating streaks. According to Hutton, the eggs, four in number, are deposited in a hole in the mud, about six inches deep. This being accomplished, the hole is filled up again with the mud previously scraped out, whereupon the female stamps upon it with her hind feet, until filled to the surface, when she beats it down with the whole weight of her body, raising herself on her hind limbs and suddenly withdrawing them, thus allowing herself to drop heavily on the earth; by these means it is so effectually beaten down that the spot where the eggs have been deposited is quite undetectable.

The RADIATED TORTOISE, *T. radiata*, of Madagascar, which attains a shell-length of a foot, is black, with large yellow spots, from which numerous bands radiate, a pattern superficially resembling that of the Star Tortoise; the radiating lines, however, are much broader. This harmless creature is much feared by the natives, who regard it as possessing the "evil eye," and nothing on earth would induce them to touch one, or even its eggs.

PHAYRE'S TORTOISE, *T. emys*, of the dry forest districts of Siam, Burma, Sumatra, and the Malay Peninsula, is characterized by a depressed shell, the depth of which is less than half its length; the posterior margins are reverted and somewhat serrated. The limbs are provided with very large, spur-like tubercles, and hence the tortoise is called by the natives of Borneo *Kura anam kaki*, which means six-footed, referring to these spurs. The species reaches a large size, the shell of a specimen which has

lived at the Zoological Gardens for the past eight years measuring two and a half feet in length. This specimen feeds almost exclusively on carrots and bananas, and, unlike all the other tortoises in the collection, does not hibernate, but remains active throughout the winter.

The GOPHER TORTOISE, *T. polyphemus*, of Florida, is remarkable inasmuch as it lives in burrows, which it only leaves on very hot days. The burrows are excavated in the sandy soil by means of its front limbs, which are armed with abnormally long claws, with the help of the plastron, which is provided with a small spade-like projection. According to H. J. Hubbard the galleries descend at an angle of 35° , and reach a vertical depth of about nine feet from the surface of the ground, measuring often as much as eighteen feet in length. The temperature at the lower end does not vary much throughout the year, not falling below 70° in winter nor rising above 80° in the summer. Once the tortoise has established itself in one of these burrows, it cannot be made to vacate or excavate a new home, but settles down for long periods, some of the burrows being known to have been inhabited by the same individual for as much as twenty-five years. The galleries, if abandoned, immediately become filled up with the shifting sand; they afford a refuge for various other animals, including opossums, racoons, and owls. The Gopher Tortoise does not survive many months of captivity, making no attempt to burrow.

The TABULATED TORTOISE, *T. tabulata*, is very abundant all over Tropical South America, and is imported in large numbers to Europe. The shell, which is very elongate, especially in old specimens, attains a length of nearly

three feet; it is often uniform dark brown in colour, sometimes black, with a yellow blotch on each shield. Although in captivity it does well on cabbage and lettuce, this species, a forest dweller, in the wild state is said to live almost exclusively on rotten fruit.

The GIANT TORTOISES:—Although at no very remote period in the past, tortoises of gigantic size were distributed over many islands, both in the Old World (Mascarenes, Madagascar, Aldabra, Seychelles) and the New (Galapagos), at the present day they are much restricted in their range, and occur, as indigenous forms, in two groups of islands only, namely, the Galapagos, off the coast of Ecuador, and Aldabra, near Madagascar, where it is believed only a small number of individuals remain. As explained by Günther, these islands were, until the sixteenth century, uninhabited by man, or, in fact, any large animals, with the result that these tortoises, endowed with a remarkable degree of longevity, living unmolested amongst luxurious vegetation and equable temperature, were to be found in enormous quantities. Leguat, for instance, who visited Rodriguez in 1691, reported that they were to be seen in flocks of two or three thousand. With the advent of man, however, who found them good to eat, they were used for provisioning passing vessels, a few being specially appointed for the purpose, each of these boats carrying some six thousand tortoises on board. The late Prof. Milne Edwards, quoting from official reports, states that in 1759-1760 altogether 30,000 were exported from Rodriguez to Mauritius within eighteen months. In the Galapagos thus the numbers were already greatly diminished at the time of Darwin's visit in 1835. Zoological

collectors are, however, responsible for their practical extinction at the present day.

These tortoises are remarkably long-lived. A specimen which was quite recently living in the compound of the Royal Artillery Mess at Port Louis, Mauritius, was taken from the French in 1810, and was at the time of the same size as at the present day. The history of another that died at Colombo in 1898 dated back over two hundred years.

The two forms which we find represented in most of the important Zoological Gardens are the Elephantine Tortoise of Aldabra, and the South Albermarle Tortoise.

The ELEPHANTINE TORTOISE, *T. elephantina*, is now nearing extinction in its native home, Aldabra, but of late years it has been introduced in the Seychelles, where it is now fortunately thriving under Government protection. The shell of large specimens measures five feet in length.

The SOUTH ALBERMARLE TORTOISE, *T. vicina*, grows to an even larger size, its shell reaching over five and a half feet in length, such specimens weighing at least five hundred pounds. It may be distinguished from *T. elephantina* by the absence of the nuchal shield.

Some interesting notes have recently been published by the Governor of the Seychelles regarding the conservation of land tortoises in the island. The largest specimen of the herd measures four feet nine inches over the surface of the carapace, and is probably the largest living specimen at the present day. "Gordon," as the creature is called, shows likes and dislikes, and is very combative, having bitten many visitors who presumed

on his apparent lethargy. The breeding season in the Seychelles extends from January to April, when the females lay their eggs in holes dug out by their hind limbs, and then covered over. The eggs, which are white, round, and the size of a tennis ball, vary in number from nine to twenty-five. The young hatch out in from 120 to 130 days, and work their way out of the ground; half the eggs are usually infertile, but in some years of great drought very few young appear, being apparently unable to reach the surface. Their rate of growth is exceedingly fast, measuring, when four years old, nearly two feet in length. When twenty-five years they are said to attain full growth.

These tortoises at our Zoological Gardens hibernate from the end of October to the beginning of March. They are fed chiefly on cabbage, of which they consume, during the hot weather, almost a bushel a week each. One large Elephantine Tortoise is peculiarly untortoiselike in his taste, being extremely fond of the bread and buns which he receives from the visitors, whom, if provided with these dainties, he will follow round his enclosure, often attracting their attention by butting against the railing of his paddock.

The members of the family CHELONIDÆ, represented by the genera *Chelone* and *Thalassochelys*, being adapted to marine life, are provided with large paddle-shaped limbs, provided with only one or two claws. The shell is covered with horny shields.

The GREEN TURTLE, *Chelone mydas*, enjoys world-wide fame, for it is from the flesh of this creature that the

famous "turtle soup" is obtained. The heart-shaped shell is smooth, polished, and slightly notched and serrated behind. The head is large, somewhat compressed at the sides. The jaws are provided with very much serrated cutting edges at the sides, the lower being hooked in front. The shell attains a length of about four feet, such specimens weighing about four hundred pounds. Although fairly abundant in all the tropical seas, the great bulk of those received in this country are obtained from the West Indies.

The eggs are deposited on the sandy shores of uninhabited islands. Before embarking on her parental duties, the female makes a thorough inspection of the beach where she has the intention of laying. Satisfied that the situation is appropriate, she digs a hole, nearly three feet deep, with her flippers, and therein deposits some two hundred eggs. These holes are then covered over with sand and levelled down by means of the flippers, in such a manner that it is only with the greatest difficulty that their place of concealment can be discovered. The whole operation of digging, laying, and filling up lasts about a couple of hours, when the turtle once more returns to the sea, leaving the eggs to be hatched by the heat of the sun. After a few weeks the young turtles break through their egg-shells, lift up the sand, and, without the slightest hesitation, make straight for the sea. Although man is perhaps their chief enemy, enormous quantities of young turtles are devoured by large fish, and only a very small percentage reach maturity.

The food of the Green Turtle consists almost entirely of fish and marine plants.

The HAWKSBILL TURTLE, *Chelone imbricata*, also a powerful swimmer, inhabiting all the tropical and sub-tropical seas, only coming to shore at the breeding season, derives its English name from its prolonged hooked snout. The carapace, the shields of which are more or less imbricate, is marbled yellow and dark brown. It is a somewhat smaller species than the Green Turtle, the shell of adult specimens rarely measuring more than three feet in length.

Although not edible, this animal is highly esteemed on account of its horny shields affording the substance known as "tortoise-shell." According to Sir Edward Tennent, the cruel method is employed in Ceylon of suspending the living turtle over fires, until the heat detaches the plates from the bone of the carapace, after which the creature is put back in the water, it being erroneously believed to return again with a regenerated shell. It appears that if the latter be removed after death the colour becomes cloudy and milky, and therefore useless from a commercial point of view.

An interesting account of the fishery resources of the Philippine Islands, which contains some interesting information on this turtle, has been given recently by Mr. Alvin Seale. During the year 1909 there were exported from the Philippines 2,040 kilograms of tortoise-shell. While a small number of turtles are caught with hook, net, spear, or trap, by far the greater number are captured when they come to shore in order to deposit their eggs, the animals being killed without being given a chance to lay, a short-sighted policy, which, unless the turtles are protected during the breeding season, which is from May

to August, will eventually result in the destruction of the fisheries.

In the Philippine Islands, it is satisfactory to learn that the method of removing the tortoise-shell from the animal's back, described by Tennent, is not resorted to, the shell in most of the islands being removed after the turtle has been killed, by immersing the carapace in boiling water until the shields loosen; another method is to bury the body in the sand for about a week, when the shields become detached. The quantities of tortoise-shell obtained from a single adult specimen varies in weight from five to ten pounds.

The **LOGGERHEAD TURTLE**, *Thalassochelys caretta*, is characterized by an enormous head. The carapace, which is very strongly arched, is uniform dark brown or black. The lower jaw is slightly hooked. Its range is even wider than that of either the Green or Hawksbill Turtles, being found much further north, and is, in fact, not uncommon in the Mediterranean and neighbouring parts of the Atlantic. It is of little value from a commercial point of view, its flesh, although not absolutely inedible being far inferior to that of the Green Turtle.

Although in fresh-water aquaria all these marine forms refuse to feed, and die of starvation in a very short time, they will live for many years under captive conditions if provided with sea-water, even in quite small tanks.

Super-family PLEURODIRA :—In these Chelonians, all more or less aquatic forms, the neck, when retracted, bends sideways.

In the family **PELOMEDUSIDÆ** the neck is completely



The Hawksbill Turtle, *Chelone imbricata*.

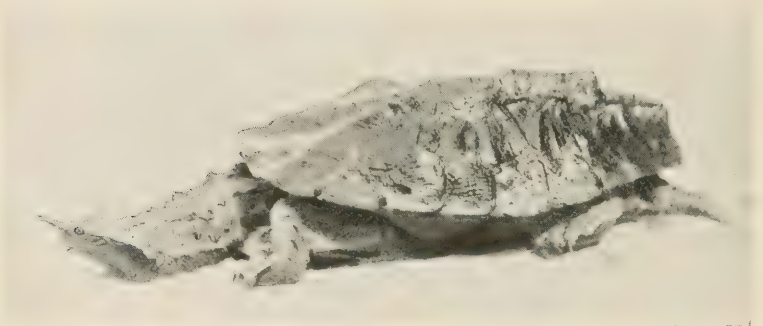


The Green Turtle, *Chelone mydas*.

(a)



(b)



(c)



- (a) The African Terrapin, *Pelomedusa galeata*.
(b) The Matamata Terrapin, *Chelys fimbriata*.
(c) The Long-necked Terrapin, *Chelodina longicollis*.

retractile within the shell. It embraces three closely allied genera, namely, *Sternotherus*, *Pelomedusa*, and *Podocnemis*, all represented in Madagascar; the two first also inhabit tropical and South Africa, while the last is represented in South America as well.

The front lobe of the plastron is movable in *Sternotherus*; *Pelomedusa* and *Podocnemis*, in which this is not the case, are to be distinguished by the fact that in the former, in common with *Sternotherus*, both pair of limbs are provided with five claws, while, in the latter, the hind limbs possess four only, as usual in tortoises and terrapins.

The twenty species belonging to *Sternotherus* are all very aquatic, and seldom leave the water, while *Pelomedusa galeata*, characterized by a flat, roundish shell, the sole representative of its genus, spends a considerable part of its existence on land.

The AMAZON TERRAPIN, *Podocnemis expansa*, of the rivers of tropical America, attains a length of two and a half feet; it is the best known of the eight members of the genus, owing to the great local commercial value of the oil produced from its eggs, of which enormous quantities are collected at the breeding season. According to Bates, who gives a lengthy account of the breeding habits and life history of this species in his book, *The Naturalist on the Amazon*, some 6,000 jars, each holding three gallons of oil, are annually exported from the Upper Amazons, and about 2,000 more jarsfull are consumed by the inhabitants, the total number of eggs destroyed annually amounting to about forty-eight millions. The eggs, which are deposited at night in deep holes, previously scraped out in the ground on the banks of

the river, are perfectly round and somewhat larger than a hen's egg.

In the family CHELYDIDÆ the neck, which is long, although bending under the margin of the carapace, remains always exposed. It is represented by eight genera, inhabiting South America, Australia, and New Guinea.

The MATAMATA TERRAPIN, *Chelys fimbriata*, certainly the most remarkable member of the family, inhabits the rivers of the Guianas and Brazil. The shell, which often carries long filamentous algæ, is very rugose and provided with three series of protuberances, thus simulating stones in the water. The extremely flattened head is more or less triangular in shape and covered with warts, while the nose is produced into a long, soft tube. This depression of the head is one of the most striking peculiarities of this animal, being paralleled by two other vertebrates only, namely, the toad *Pipa*, and the fish *Aspredo*, both of which inhabit the same rivers as does this terrapin. The chin and neck afford yet another remarkable feature, being provided with a number of movable fleshy appendages which, in the water, somewhat resemble small worms, these "whiskers" being believed to serve the useful purpose of attracting the fish upon which the creature feeds, the latter being snapped up before realizing their mistake.

The Matamatas at the Zoological Gardens are by no means exclusively fish-eaters, being just as fond of meat.

The LONG-NECKED TERRAPIN, or SNAKE-NECKED TERRAPIN, *Chelodina longicollis*, is so called on account of the extraordinary length of its neck, which, when fully extended, exceeds that of the shell, a length of nearly a foot. This terrapin, an exceedingly common species inhabiting

Australia, although spending a considerable part of its life on land, will, curiously enough, only feed under water. It can be thoroughly recommended as a pet, becoming very tame, and living many years under captive conditions.

The SOUTH AMERICAN LONG-NECKED TERRAPINS, *Hydro-medusa tectifera* and *H. maximiliani*, greatly resemble *Chelodina*, possessing an equally long neck. They differ in various osteological characters, and in the curious disposition of the dorsal shields, the nuchal being shifted back behind the marginals, simulating an additional vertebral.

In *Hydraspis*, of South America, a genus composed of ten thoroughly aquatic species, the shell is very much flattened; the neck is comparatively short; the chin is always provided with a pair of fleshy appendages, which, however, differ much in size and shape.

ST. HILAIRE'S TERRAPIN, *Hydraspis bilarii*, the largest of these terrapins, attaining a shell-length of two and a half feet, may be recognized by its very large club-shaped barbels. Some specimens, which have been living in our gardens for the past fifteen years, will, when forced to leave the water, on occasions, for instance, when their tank is being cleaned out, emit at intervals, for no apparent reason, a loud hissing sound, which frequently develops into a shrill whistle.

Super-family TRIONYCHOIDEA :—In these river turtles, which constitute the single family *Trionychidæ*, the neck bends by an S-shaped curve in a vertical plane, as in the *Cryptodira*. There are no epidermal shields, and the members of this family may at once be recognized by the round flat carapace, covered with soft skin, by the

tube-shaped appendage at the end of the snout, and by the fact that the jaws are concealed by fleshy lips. As the name indicates, the limbs have only three claws.

Trionyx is represented by a number of species both in the Old and New World. They are very powerful, and of ferocious habits, their sharp, cutting jaws and the rapidity with which they are able to project their necks rendering them highly dangerous.

The GANGETIC TRIONYX, *T. gangeticus*, is the largest species, its shell alone, which is dark olive in the adult, vermiculated with fine dark lines in the young, attaining a length of over two feet. The flesh of this species is said to be most excellent eating, and is highly appreciated by the natives. Theobald, in the *Journal of the Linnean Society*, gives the following lively account of the capture of this species : " In hunting for the soft Turtles in the hill streams, the men use a long iron fork, such as an old iron ramrod, sharpened at one end, or a stout strip of bamboo, which they thrust down for a foot or two in the soft vegetarian sludge and decayed leaves found along the margins of deep pools in the hill-streams.

" If a fork touches a Turtle concealed below, the motion of the animal is felt : a cautious examination is then made with the hand, and a fish-hook is cleverly inserted in the soft part about the tail. A steady haul is now made, and out comes the Turtle, wildly floundering and snapping at everything within its reach with pertinacious ferocity.

" Sometimes, when the animal is large and the water deep, a stake is held over the animal's back, and, with a few well-delivered blows of a mallet, driven through both shells. Woe betide the limb, however, which comes

within reach of the infuriated animal ! I saw the top of a man's toe bitten clean off by a trionyx which was being 'staked,' and, as these animals are both active and ferocious, it is always advisable to send a bullet through their brain as soon as possible. So tenacious of life, however, are these creatures, that their heads bite vigorously after being completely dissevered from their bodies."

The NILE TRIONYX, *T. triunguis*, grows to almost as large a size as the latter species. It is common in the Nile, and is also found in Syria, the Senegal, and the Congo. It is olive above, closely dotted with pale yellow in the young; the lower surface is white, with indistinct dark network. The Arabs have a certain respect for this turtle, as they say it searches for the eggs of the crocodile digging them out and devouring them.

In the New World the Soft-shelled Turtles are represented by four species, none of which exceed eighteen inches in length. The commonest form is *T. ferox*, which inhabits the rivers of the South-Eastern States, from Georgia to Florida and the Gulf of Mexico.

CHAPTER III

CROCODILIA—CROCODILES, ALLIGATORS, ETC.

CROCODILES, Alligators, and their allies, although perhaps not attaining quite so great a length as some of the large constricting snakes, are at any rate by far the bulkiest of living Reptiles. They are elongate, four-limbed creatures, with the body covered with thick scales, some or all of which are underlain by bony plates, those of the back being keeled and elevated in longitudinal ridges, while those of the ventral surface are squarish and smooth. The snout varies much in shape; in the Alligators it is broad and roundish, in the true Crocodiles, as a rule, more or less pointed, while in the genera *Gavialis* and *Tomistoma* it is extremely narrowed, with spatulate end. The eyes, nostrils, and external ears are situated on the upper surface of the head, so that the breathing, seeing, and hearing is unimpaired when the animal is in the water, the upper part of the head being usually raised above the surface when swimming. The nostrils and ears are furnished with movable valves, which are kept shut when the animal is under water, while the eyes are provided with a nictitating membrane, as well as with a lower and an upper eyelid. The teeth, which are renewed periodically, are placed in a single row and, unlike those of all other recent Reptiles, are implanted in sockets, those of the upper jaw usually overlapping those of the lower. The digits are five to the anterior, four to the posterior extremities,

those of the latter being invariably webbed, those of the former usually so. Only the three inner digits are clawed. The compressed tail is a powerful organ, mainly adapted for propulsion in the water, but serving also as a powerful weapon of attack and defence.

From lizards, with which they were formerly associated, Crocodiles differ in various important anatomical characters, the ribs, for instance, being forked at the articulation with the vertebræ, while the abdomen is as, in *Sphenodon*, protected by transverse series of bones.

Crocodiles and Alligators are mainly carnivorous, feeding on mammals and waterfowl, for which they lie in wait close to the edge of the water, sweeping them in by a blow of their tail. The Gharials throughout life feed almost exclusively on fish. All are oviparous, laying oval, hard-shelled eggs, which are often deposited in "nests," constructed and watched over by the female, and, in the majority of cases, incubated by the heat of the sun. The embryo Crocodile is provided with a large "egg-tooth," situated at the extreme end of the snout, its function being to help in cutting through the hard shell. This "tooth" soon becomes loose, and is shed a day or two after birth. The young are most aggressive immediately they leave the egg, snapping and biting after the manner of their parents. Most species hibernate or estivate in the mud on the banks of the rivers or ponds for at least three months in the year.

The order is represented throughout the tropical and semi-tropical parts of the globe by the single family, the CROCODILIDÆ, which embraces six genera, viz. *Alligator*, *Caiman*, *Crocodylus*, *Osteolæmus*, *Gavialis*, and *Tomistoma*.

In the ALLIGATORS, genus *Alligator*, the fourth tooth of the lower jaw, the largest, fits into a pit in the upper. The ventral bony scutes are very thin, or even entirely absent.

Until the year 1870, when a species belonging to this genus was reported from China by the explorer Swinhoe, Alligators were believed to inhabit the New World only.

The COMMON ALLIGATOR, *A. mississippiensis*, of the South-Eastern United States, is still very abundant in certain parts of its habitat, in spite of the fact that large numbers are killed every year for the purposes of procuring their hide. The head is nearly twice as long as broad, the snout rounded at the end, and much depressed, with the lateral outline almost straight. The fingers are scarcely half, the toes about three-quarters, webbed. In the adult the colour is dark green or blackish above, yellowish with black cross bands in the young. Although attaining a total length of fifteen feet, it is sexually mature when only about eight. The rate of growth of this creature is very much faster than is generally supposed, as is shown by the following observations, made by Mr. R. L. Ditmars, on the growth of a specimen in the New York Reptile House.

<i>Hatched October 1900.</i>	<i>Length.</i>	<i>Weight.</i>
October 1900	8 in.	1 $\frac{3}{4}$ oz.
" 1901	2 ft. 6 in.	3 $\frac{3}{4}$ lb.
" 1903	3 ft. 9 in.	14 lb.
" 1906	6 ft. —	60 lb.
" 1912	9 ft. 3 in.	190 lb.



The Nile Trionyx, *Trionyx niloticus*.



The Ganges Trionyx, *Trionyx gangeticus*.



American Alligators, *Alligator mississippiensis*.

The breeding habits of the Alligator are of very considerable interest. The female lays her eggs, which number from twenty to thirty, in a nest constructed of twigs, leaves, rushes, etc., which are packed down by the animal on an elevation some two or three feet high, on the bank of the river or lagoon, a few yards away from the hole she inhabits. The eggs having been deposited in the nest, which measures from seven to ten feet in diameter, they are immediately covered over with damp, decaying vegetable matter, which evidently helps in their incubation, as the inside is always damp, however high the temperature outside may be. They are hatched in about two months. For a few hours prior to breaking through the egg-shells, the young alligators make a loud squeaking noise for the purpose of attracting their mother's attention, in order that the nest may be opened up for them, as otherwise they would, in all probability, be incapable of digging their way out of the compact mass of twigs and reeds.

Alligators, although treacherous and vicious beasts, are great cowards, and captive specimens give little trouble, the keepers in our Zoological Gardens entering the tank of the largest specimens, for cleaning out purposes, without running the slightest danger of being attacked.

Adult specimens, when excited or annoyed, will frequently produce loud and prolonged roaring sounds, not unlike those of a lion.

The CHINESE ALLIGATOR, *A. sinensis*, whose home is the Yang-tse-Kiang, may be distinguished from its American ally by the fact that the fingers are entirely free from a web, and by the dorsal scutes of the broadest series

numbering six instead of eight. It differs also somewhat in colour, the dark background being minutely speckled with yellow or white. In size it is much smaller, never exceeding seven feet in length. The Chinese Alligator usually becomes very tame in captivity, and a six-foot-long specimen, which has lived for the past twenty-three years in our gardens, is extremely docile, allowing itself to be picked up and petted. The voice of this species is totally different to that of the American Alligator, the sounds produced being sharp and sudden, never prolonged, and always repeated several times in rapid succession.

In the genus *Caiman* the fourth tooth of the lower jaw fits into a pit in the upper, as in the Alligators. Unlike in the latter, however, the ventral surface is protected by an armour of bony scutes. The Caymans, of which eight species are distinguished, are restricted to Central and South America. The largest member of the genus, *C. niger*, attains a length of nearly twenty feet; eight feet is the maximum length of the other species.

The SPECTACLED CAYMAN, *C. sclerops*, is so called on account of its possessing a strong ridge, situated in front of and between the eyes, which combines with the ridges round them to resemble a pair of spectacles. It is the commonest species, and is extremely abundant throughout Central and South America, and, in fact, Bates has stated that, in certain localities, some of the waters may be said to be as well stocked with caymans as an average ditch in England is with tadpoles.

The BROAD-SNOUTED CAYMAN, *C. latirostris*, inhabiting South America, east of the Andes, is characterized by an extremely broad and rounded snout, its basal width

equalling its length. The upper eyelid is very rugose and is frequently produced into a small horn.

The Caymans are all uniform dark brown or blackish.

Although reputed to be more vicious and sometimes ready to attack, their habits are otherwise similar to those of Alligators.

Osteolæmus, represented by a single species, *O. tetraspis*, which reaches a maximum length of only six feet, is restricted to West Africa. Superficially it resembles a Cayman, the snout being short and blunt, while the head is rugose and the space between the eyes raised; the fourth tooth of the lower jaw fits, however, into a notch in the upper jaw, as in Crocodiles proper, from which it differs only in certain cranial characters.

In the true CROCODILES, genus *Crocodylus*, the fourth tooth of the lower jaw fits into a notch in the upper, as in *Osteolæmus*, not in a pit, as in the Alligators and Caymans. Their distribution embraces Africa, Asia, North Australia, and Tropical America.

The NILE CROCODILE, *C. niloticus*, attaining a length of eighteen feet, was formerly very common in Lower as well as Upper Egypt, and was worshipped by the ancient Egyptians and fed by the priests. Towards the end of the seventeenth century it was still to be met with above Cairo. It occurs at the present day in the rivers and lakes from Wadi Halfa and the Senegal southwards to South Africa; it is also found in the waters of Madagascar.

The snout is rather pointed, being once and two-thirds to twice as long as broad at the base. The fingers are slightly webbed, the toes extensively so. The dorsal scutes are arranged in sixteen or seventeen transverse, and six

or eight longitudinal series. The colour is dark brown or olive, lighter on the sides; in the young it is yellowish, speckled or banded with black.

This Crocodile lays from forty to sixty eggs, which are deposited during the spring in holes in the sand, where they are hatched in from four to six weeks, the young at once making for the water.

The Nile Crocodile is credited with very great ferocity, and as it is annually responsible for the loss of many lives, in certain localities, the plan of paying a small sum to the natives for every egg collected has been adopted, with the result that in such parts the young crocodiles are gradually being reduced in numbers. Many eggs are dug up and eaten by Monitor Lizards, and possibly by Trionyx Turtles.

The AMERICAN CROCODILE, *C. americanus*, of Central and South America greatly resembles the Nile Crocodile, but may be distinguished by the presence of a longitudinal swelling, or ridge, along the middle of the snout. The dorsal scutes are disposed in fifteen or sixteen transverse, and four or six longitudinal rows.

This crocodile, which is quite similar in colour to *C. niloticus*, attains a length of about fifteen feet. It has a decided preference for brackish water, and is even occasionally met with in the open sea, some distance away from the mainland.

The MUGGER, *C. palustris*, is found throughout India, Ceylon, and Burma, but is very rare in the Malay Peninsula and Archipelago. The snout is shorter and broader than in the other Crocodiles. The maximum length attained is about sixteen feet.



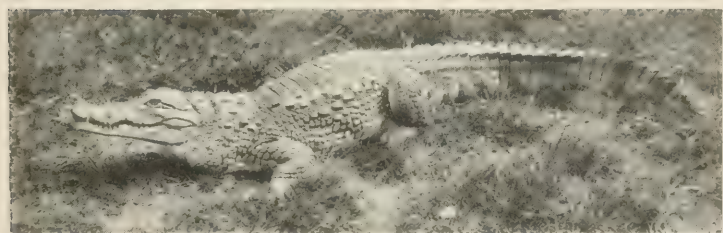
(a)



(b)



(c)



(d)

- (a) Egg of Alligator.
 (b) Chinese Alligator, *Alligator sinensis*.
 (c) West African Crocodile, *Osteolaemus tetraspis*.
 (d) The African Crocodile, *Crocodilus niloticus*.



Gharial, *Gavialis gangeticus*.

During the dry season, when the watercourses dry up, Muggers are occasionally encountered in the jungles, in search of water, although during the very dry weather they generally bury themselves in the mud, and there estivate until the recurrence of rain. They are of cowardly and timid disposition, and very few cases of their having attacked man are on record.

The MARINE CROCODILE, *C. porosus*, of the east coast of India, Ceylon, Burma, and Southern China to North Australia, enters salt water, and frequently occurs many miles out at sea, being seldom, in fact, found above the tideway of rivers. It is to be distinguished from the preceding species, with which it is frequently confounded, by a longer snout, and by the presence of a longitudinal ridge in front of each eye. The largest member of the order, attaining the tremendous length of thirty-three feet, is very bold and vicious, and will attack even when not pressed by hunger.

The AUSTRALIAN CROCODILE, *C. johnstonii*, and the WEST AFRICAN CROCODILE, *C. cataphractus*, are characterized by a slender snout, which is about three times as long as broad at the base, and thus approaches somewhat the condition exhibited by the Gharials.

The voice of the majority of Crocodiles resembles that of the Chinese Alligator, taking the form of a sharp and frequently repeated bark.

In the genera *Gavialis* and *Tomistoma*, which are represented each by a single species, the snout is extremely long and slender, like a cylindrical rod, swollen at the end, and provided with numerous sharp interlocking teeth, well adapted for catching fish.

The GHARIAL, *Gavialis gangeticus*, which reaches a length of nearly thirty feet, is fairly abundant in the Ganges and Indus. Adult male specimens have a large cartilaginous swelling on the extreme tip of the snout, perforated by the nostrils, containing a chamber for the reception of air, enabling them to remain for a considerably longer period under water, than in the case of females.

Although possessing the reputation of being more or less harmless, the stomach of a recently dissected specimen was found to contain human remains, a fact proving beyond all possible doubt that large specimens, at least, will not hesitate to attack man when hungry.

Two seven-foot-long specimens that have come under my charge at the Zoological Gardens were extremely savage. On arrival both these specimens refused all food, and it was not until they had been over three months in captivity that they took their first meal. The fish are caught by the tip of the snout, by means of a rapid sideways snap, and are passed down to the mouth, head first, in a series of jerks.

The eggs of the Gharial, about forty in number, are buried in two layers, half below and half above, separated from each other by a foot or two of sand.

The TOMISTOMA, *Tomistoma schlegeli*, or False Gharial, as it is often called, on account of its resemblance to the true Gharial, from which it differs chiefly in the arrangement of the bones of the skull, is a native of the Malay Peninsula, Borneo, and Sumatra. It attains a maximum length of fifteen feet. Its habits are unknown, but naturally believed to be similar to those of the true Gharial.

CHAPTER IV

LACERTILIA—LIZARDS

EVEN the most casual observer cannot fail to distinguish lizards from tortoises, while the absence of a movable tongue, and the longitudinal cleft of the vent, are characters by which a Crocodilian can at once be separated from any type of lizard, to say nothing of the dentition and various anatomical characters which do not appeal to the superficial observer. From snakes, however, the distinction is not so apparent, for, although the great majority of lizards have four well-developed limbs, provided with five clawed digits, it must be borne in mind that in a number of families there is a tendency to lose these organs, and for the toes to become gradually reduced, and that in a few degenerate types, such as our Common Slow-worm, they are even entirely absent. Rudiments, at least, of both pectoral and pelvic girdles are, however, always present. The possession of eyelids and ear-openings is the general rule, but here again there are exceptions, and too much reliance cannot therefore be placed on these external features. In the structure of the lower jaw, however, we have a character by means of which the two orders may be most conveniently separated, for in lizards the mouth is non-expansible, the two halves of the lower jaw

being united by suture, while in snakes the mouth is highly expansible, the rami of the lower jaw being connected together by an elastic ligament. Apart from this character, the bifid tongue of snakes is invariably retractile within a basal sheath, which is not the case amongst lizards, except Monitors and a few Teiids.

Lizards present a remarkable variety of types, some being adapted either for climbing, running, swimming, "flying" (parachute bearers), or crawling like snakes, whilst others live underground and have become degenerate, assuming the appearance and movements of worms. The feet may be adapted for grasping the branches of trees, as in the Chameleons, or they may be provided with adhesive pads, for ascending smooth surfaces, as in the Geckos. The tongue differs to a very great extent in shape, according to its function: it may be broad and short, and merely an organ of taste, as in Geckos and Agamas, or very long and forked, as in Monitors, where it acts as a feeler, while in Chameleons it is extremely exsertile and provided with a sticky club-shaped end, adapted for shooting at insects.

The tail of many lizards is extremely fragile, and easily broken off, the fragility being evidently of use in allowing them to escape when seized by their enemies. The vertebræ of the tail are divided by a septum into two halves, the breaking taking place at that weak point, and not, as has sometimes been stated, between two vertebræ, which are usually furnished with a socket-and-ball articulation.

When the tail has been broken, it grows again, sometimes even in a double or triple form; the vertebræ are, however,

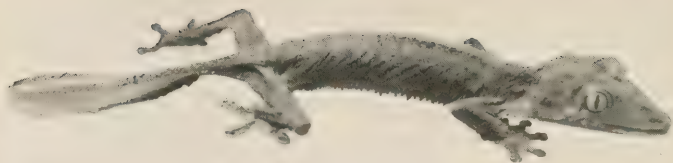


Verticillated Gecko, *Gecko verticillatus*.

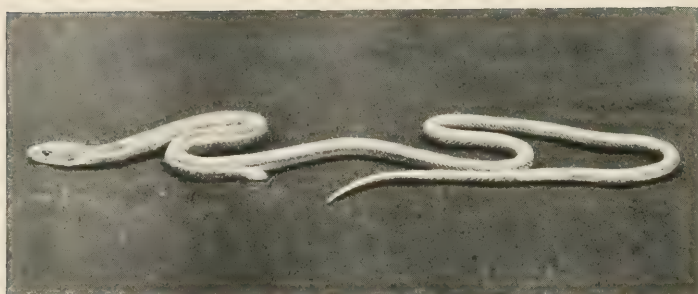


Verticillated Gecko, ventral view.

(a)



(b)



(c)



- (a) Fringed Gecko, *Uroplates fimbriatus*.
(b) Scale-footed Lizard, *Pygopus lepidopus*.
(c) Fat-tailed Gecko, *Gymnodactylus milvisii*.

not reproduced, the axis being replaced by a continuous rod of calcified tissue. The scaling on the reproduced portion often differs from that of the uninjured part.

The arrangement of the teeth is of importance in the classification of lizards; for instance, two great families, the *Agamidæ* of the Old World, and the *Iguanidæ* of the New World, being simply distinguished by their dentition, this being acrodont in the former, pleurodont in the latter (see p. 6, fig. 1). In one family only, the *Helodermatidæ*, containing a single genus, are the teeth fang-like, and provided with a groove which conveys a poisonous fluid secreted by special glands.

The skin, which is shed periodically, mostly in flakes, but sometimes entire, is invariably covered with scales or tubercles; in the worm-like *Amphisbænidæ*, however, these scales are soft, and appear more as divisions of the integument.

The food of lizards varies; the majority are insectivorous, some, however, such as the large Monitors, feed on birds, small mammals, and eggs, whilst others, such as many of the Iguanas, are mainly vegetarian.

As a general rule lizards lay eggs, which are deposited in mould or sand: a few, such as the Common Lizard, the Slow-worm and most of the Skinks, bring forth their young alive.

The GECKOS, family GECKONIDÆ, represented in all the tropical and warmer parts of the world, have usually dilated digits, the digital pads serving as adhesive organs, by means of which they can stick to smooth surfaces; in some, however, especially in those living in barren regions,

these pads are absent, the digits being similar to those of many other lizards, being sub-cylindrical, and keeled or denticulated inferiorly. The non-dilated digits are often angularly bent at the articulations, and are provided with strong claws, which may be retractile into a sheath. The eye is large and devoid of lids, being protected by a transparent disc, which covers it like a watch-glass. The tongue is fleshy, moderately elongate, and little protrusible. The dentition is pleurodont.

Some of the genera are arboreal, living in woods, concealed during the daytime under dead leaves, or the bark of trees; others take up their abode in houses, while a few inhabit arid regions, burrowing in the sand. The majority are nocturnal, a few only diurnal.

Col. Tytler has published some interesting observations on the habits of these creatures. He observes that: "Although several species of Geckos may inhabit the same locality, yet, as a general rule, they keep separate and aloof from each other; for instance, in a house the dark cellars may be the resort of one species, the roof of another, while the crevices in the walls may be exclusively occupied by a third species. However, at night they issue forth in quest of insects, and may be found mixed up together in the same spot; but on the slightest disturbance, or when they have done feeding, they return hurriedly to their particular hiding-places." Some three hundred species are known, divided into nearly sixty genera.

The MOORISH GECKO, *Tarentola mauretanica*, of Southern Europe and North Africa, and DELALANDE'S GECKO, *Tarentola delalandii*, of the Canary Islands and West Africa, are the two small forms most commonly kept in

captivity in this country. The digits are strongly dilated and provided with a large, flat scute on the upper surface near the tip, shaped like a nail. The upper surface of the body, which is grey or brown in colour, as well as the limbs and tail, are covered with granules of unequal size, intermixed with large tubercular scales arranged symmetrically on the back and tail.

Large numbers of Delalande's Gecko are constantly being sent to the Zoological Gardens from greengrocers' shops, the lizards being brought over from the Canary Islands concealed in bunches of bananas. They have a remarkable facility for discarding their caudal appendage when seized, and specimens with perfect tails are rarities.

The VERTICILLATED GECKO, *Gecko verticillatus*, one of the largest known, reaching over a foot in length, is common in Eastern Bengal, Southern China, and the Malay Peninsula and Archipelago, frequenting the trees in the jungle, and occasionally entering houses. It is a remarkably handsome creature, being light blue or slate grey in colour above, with numerous round orange or red spots; the under-surface is whitish, variegated with grey. The digits, which are large, are dilated and free.

It is known to the natives by the name of Tokay, expressive of its call, which it utters many times in rapid succession, usually seven or eight times, sometimes, however, as many as eleven. It feeds not only on insects, but also on lizards and mice, and is even said to take young birds from the nest.

The FLYING GECKOS of the genus *Phychozoon*, also inhabiting the Malay Peninsula and Archipelago, reaching a length of eight inches, are so called on account of their

possessing a well-developed expansion on each side of the body, which is supposed to be of use to the creatures in parachuting from one tree trunk to another. Annandale, however, is of the opinion that the use of the structure is not to support the lizard in the air, but to assist in concealing itself by causing it to fit better into its surroundings, and thus to be less conspicuous than it would be if its body cast a shadow beneath it.

The genus is represented by two species, *P. homalocephalum* and *P. horsfieldii*. In both the limbs and sides of the head, in addition to the sides of the body, are provided with a much-developed membranous expansion. Cantor, who has kept the former species in captivity, says that it has the power of changing rapidly from a very pale to an almost black tint.

The genus *Gymnodactylus*, with a distribution which embraces South Europe, Asia, Australia, and South America, has the digits undilated.

In the NAKED-TOED GECKO, *G. miluisii*, of the arid sandy districts of Eastern and Southern Australia, the tail is much swollen, being nearly as broad as the body. Unlike other Geckos, this species, when in progression, bends and raises its body free from the ground, after the manner of a kitten, as the reader may observe from the photograph, showing the creature in this strange attitude.

The family UROPLATIDÆ, of Madagascar, containing a single genus, *Uroplates*, combines with a geckoid structure a peculiar sternal apparatus.

The BARK GECKO, *U. fimbriatus*, so called on account of its protective resemblance to the bark of the trees on which it is found, has quite a short tail, which is surrounded by

a broad membrane with rounded outline; the body and limbs are bordered by strongly denticulated folds. The digits are very strongly dilated, their power of adhesion being so great that once the lizard has fastened itself to an object it is often almost impossible to remove it.

The members of the Australian and Papuan family PYGOPODIDÆ are snake-like in appearance, being entirely devoid of fore limbs, while the hinder ones are absent or merely represented by scaly flaps, under which the digits are hidden. The exact position of this family in the system is rather dubious, as, although the structure of the skull approaches that of the Geckos, there are many anatomical differences. The eyes, the pupil of which is vertical, are, as in the majority of Geckos, devoid of lids.

The family is represented by six genera, of which the uniform slate-coloured *Pygopus lepidopus*, attaining a length of two feet, is the commonest species.

The Old World lizards of the family AGAMIDÆ are characterized by their acrodont dentition. The limbs and eyelids are well developed. The tongue is thick, entirely attached, or but slightly free in front. The tail, which may be exceedingly long, is not fragile, and is prehensile only in the genus *Cophotis*. In a number of species ornamental appendages, such as crests and gular pouches, are present, sometimes in the males only, sometimes in both sexes. The shape of the body and the scaling varies according to the modes of life adopted by the genera, and although, generally speaking, the ground Agamids have the body depressed, and the arboreal species compressed, there

are many exceptions, which necessitate the abandoning of the formerly accepted division of the genera into terrestrial and arboreal.

The *Agamidæ* inhabit Africa, Asia, Australia, Polynesia, and South-Eastern Europe. They are absent from Madagascar and New Zealand.

Draco is the most highly specialized genus, its representatives being the FLYING LIZARDS or DRAGONS, of which there are some thirty species, restricted to the Oriental

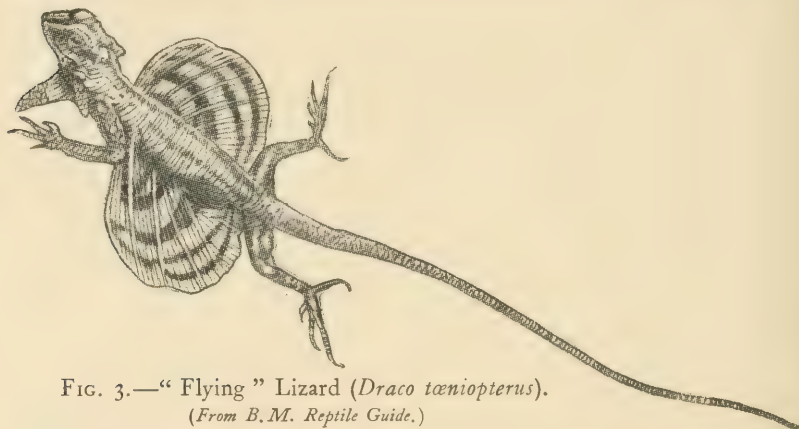


FIG. 3.—“ Flying ” Lizard (*Draco tæniopterus*).
(From *B. M. Reptile Guide*.)

Region, being especially abundant in the Malay Peninsula and Archipelago. They are characterized by an apparatus for locomotion in the air, composed of five or six prolonged ribs, connected by large expansible folds of the skin, on each side of the body, the so-called “wings,” which support the lizard, parachute-like, when jumping from branch to branch, and fold again against the sides of the body when the lizard alights.

According to Captain Stanley Flower, who has had the opportunity of seeing these creatures in their native surroundings, they are able to direct their flight exactly,

as they glide through the air, with their wings quite steady, for distances of over twenty yards, alighting gently on all fours, and closing their parachutes as they settle on the trunk of a tree. In the act of flight they are as beautiful as the most gorgeously marked butterflies, the under-surface of the wings being in most species ornamented with bright red, yellow, or orange; at rest, however, they are very insignificant-looking creatures, being of a dull colour, harmonizing with the tree trunks. Another interesting point in connection with the Flying Lizards is their possession of a much-developed inflatable gular pouch or appendage, which, in the males, may attain a length of more than three times that of the head. These lizards are of small size, seven to fifteen inches, in which the tail enters for nearly two-thirds.

The commonest and best known species is *D. volans*, from the Malay Peninsula and Archipelago, the largest is *D. maximus*, from the Malay Peninsula and Borneo.

Calotes is a genus composed of twenty-five more or less arboreal species, restricted to the Indian region. The body is compressed, the tail is long. A well-developed dorsal and nuchal crest is invariably present.

The BLOODSUCKER, *C. versicolor*, the habitat of which ranges from Ceylon and India eastwards to Southern China and the Malay Peninsula, and westwards to Baluchistan, attains a length of fifteen inches, of which the tail accounts for almost three-quarters. Its popular name is derived from the fact that, when excited or alarmed, its throat, which under normal circumstances is of a pale yellowish flesh colour, immediately becomes much dilated and of a brilliant scarlet. During courtship the

male behaves in a most peculiar manner, dancing in front of the female, standing with the fore-part of the body raised on its fore-legs, bowing its head repeatedly, and continually opening and shutting its mouth.

In *Agama* the body is somewhat depressed, with a dorsal crest, which, if at all present, is but feebly developed. A group of spines is often situated on the sides of the hinder part of the head.

The Agamas, the species of which number over fifty, represented throughout Africa, Southern Asia, and South-Eastern Europe, are usually found in barren localities. The Egyptian species are called by the Arabs "judge of the desert," in allusion to the way in which they raise the head, as if surveying the surroundings.

Some of the lizards of this genus, especially *A. colonorum*, of West Africa, rival the chameleons in the rapid and striking changes of colour which they undergo.

According to Mr. W. A. Lambon, the latter species is found in groups of six or seven females, headed by a male, the females looking to one lord and master only. Their respect for the male is such, that if one of them drops a number of butterflies, they almost invariably wait for the male to take his fill before satisfying their own appetites, and not without good reason, for, should one of the females presume to attempt to share the meal, the male becomes so filled with the desire to inflict vengeance, that he will desert his prey to chase and admonish the offender. Females so greatly outnumber males that the former are forced to various artifices to secure their share of his attendance, such solicitation taking the form of running up and performing various antics in front of him. The males are very



The Bloodsucker, *Calotes versicolor*.



Bearded Lizard, *Amphibolurus barbatus*.



Frilled Lizard, *Chlamydosaurus kingi*.

pugnacious, and fight with much courage with those of their brethren that presume to poach upon their preserves.

The genus *Chlamydosaurus*, of Australia, is represented by a single species, *Cbl. kingii*, the FRILLED LIZARD, which is remarkable on account of its possessing a large frill-like expansion on each side of the neck, confluent with the throat, which, when fully expanded, almost completely surrounds the head. The expansion is accompanied by the opening of the mouth, the two actions corresponding, neither being exercised independently of the other, and the relative elevation of the frill is in direct proportion with the gape of the mouth, giving the creature, when the frill is fully extended, a most ferocious appearance. The use of this frill is undoubtedly to frighten away its enemies, and it is only erected when the animal is on the defensive, for when at rest, as in the case of the "wings" of the Flying Lizards, it is folded along the sides of the body. The action is merely a piece of "bluff," for in reality, in spite of its formidable appearance, this lizard is very harmless, and seldom makes any attempt to bite. The Frilled Lizard is further remarkable for its habit of running along the ground on its hind limbs, in a perfectly upright position, with its tail elevated clear of the ground, and, as pointed out by Saville-Kent, who was able to confirm previous reports as to this habit, the tracks left behind, when passing over soft soil, correspond to those of a bird, for only the three central digits rest on the ground when it assumes an upright position. This lizard, which attains a maximum length of three feet, lives in woods, where it feeds almost exclusively on insects; captive specimens have been known to accept meat.

Amphibolurus, composed of sixteen species, also restricted to Australia, has a large and thick head; the body is much depressed; the tail is rounded.

The BEARDED LIZARD, *A. barbatus*, of South Australia, has the sides of the neck covered with numerous spines, while the skin of the throat is covered with bristle-like scales, which, when the mouth is opened, are erected in the manner of the frill in *Chlamydosaurus*, presenting a likeness to a beard. The tail of the creature is covered with large spinose scales, arranged in more or less regular cross series, forming a very formidable weapon of defence, and with which it is able to inflict quite serious wounds.

The eggs of this creature, usually eight in number, are connected by membrane in a row.

The Bearded Lizard is imported to this country in large numbers, and is, for some unknown reason, frequently offered for sale under the name of the Frilled Lizard, to which it bears not the slightest resemblance. Specimens I have kept were strictly carnivorous.

The genus *Physignathus* embraces semi-aquatic lizards, natives of Australia, Siam, and Cochin-China. With their large and thick heads they are not very unlike *Amphibolurus* in appearance; the tail and body, however, are compressed, while a low dorsal and nuchal crest is constant in all seven species.

LESUEUR'S LIZARD, *P. lesueuri*, restricted to Queensland, where it is very abundant, is a hardy, though nervous creature, living for years in confinement if given roomy quarters; in a small cage, however, it sulks and refuses to take food, the latter consisting of both vegetable and animal matter. In colour it is of a light brown or grey

above, paler on the sides, with a broad dark streak running from behind the eye to the back of the head; the under-surfaces are often brick red.

Although not very rapid in its movements, it is an extremely active lizard, climbing with the greatest facility to the top of trees. When alarmed I have often observed its locomotion to be, for short distances, bipedal; the tail, however, is not raised any distance from the ground, as is the case in *Chlamydosaurus*.

The MASTIGURES, genus *Uromastix*, live in the desert regions of North Africa and South-Western Asia, where they construct deep burrows in the sand, into which they retreat at night and hibernate during the winter months. They are characterized by a very flattened body, a small, rounded head, and a much swollen tail, which is covered with whorls of large spines.

The commonest species, *U. acanthinurus* and *U. spinipes*, of North Africa, and *U. hardwickii* of Northern India, the two former attaining a length of about fifteen inches, are annually imported to Europe in large numbers, and may be purchased for a few shillings. The African species may be distinguished from the Indian one by the whorls of the spinose scales, not being separated from one another by small granular scales, as in the case of the latter.

Although occasionally biting, the majority make use of their tail as a means of defence, freshly captured specimens lashing vigorously from right to left with this organ, the spines, at least in the case of the African species, being sharp enough to draw blood from the hand in which the lizard is held.

Captive specimens, like the majority of desert forms,

require tremendous heat, combined with plenty of sunshine, and during the summer months, when these conditions are obtainable, they are fairly active, consuming large quantities of meal-worms and lettuce. In the autumn, however, when the sun has failed to put in an appearance for several days in succession, they become sluggish, refuse all food, and remain stretched out with their eyes closed, as if dead, and only a very small percentage live through our winter.

The SPINY LIZARD, or YORK DEVIL, *Moloch horridus*, a small, six-inch-long lizard, inhabiting the arid districts of Southern and Western Australia, is the sole representative of its genus. It is without doubt by a long way the most grotesque of all lizards, for the entire body, head, and limbs are covered with enormous spines, the largest, which are nearly half an inch long, being situated above the eyes, in front of the ear, and on each side, behind the angle of the mouth; the neck, which is as long as the head, and separated from it by a fold, is provided with a transverse row of spines, followed by a globular protuberance, covered with enlarged scales, and a pair of large conical projections pointing forwards and backwards. The head is small and short, the eye minute. The colour of this creature is chestnut brown, with symmetrical markings of black and yellow.

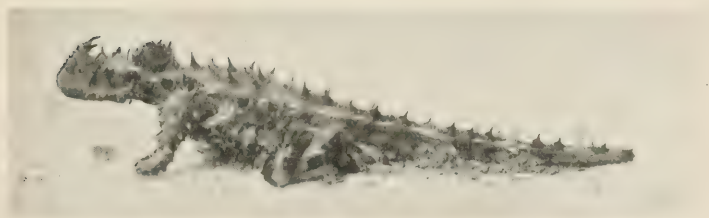
In spite of its repulsive appearance, the York Devil is in reality quite harmless, relying merely on its spiky armour for protection. The two specimens kept by the writer did not live long, as at the maximum temperature with which he was able to provide them, 75°–80°, they evidently felt chilled, and refused to feed. Their food is



(a)



(b)



(c)

(a) Lesueur's Water Lizard, *Physignathus lesueurii*.

(b) The Egyptian Mastigure, *Uromastix spinipes*.

(c) Moloch Lizard, *Moloch horridus*.

(a)



(b)



(c)



(a) American Basilisk, *Basiliscus americanus*.

(b) Carolina Anolis, *Anolis carolinensis*.

(c) Undulated Lizard, *Sceloporus undulatus*.

said to consist exclusively of ants, which, according to Saville Kent, they devour in amazing quantities; this naturalist, who studied the creature in its native land, calculating that a single individual consumed as many as fifteen hundred at a single meal, each ant being picked up separately with the tongue.

The family IGUANIDÆ, with the exception of two genera in Madagascar, and one in the Fiji Islands, is restricted to the New World, there replacing the *Agamidæ*, from which it is distinguished by the pleurodont dentition. With the exception of the “flying” lizards, all the principal forms represented amongst the Agamids are repeated in the Iguanids.

The lizards are generally insectivorous or herbivorous, a few only feeding on both animal and vegetable matter; *Amblyrhynchus cristatus*, the only lizard known to enter salt water, feeds exclusively on sea-weeds.

Anolis is a genus composed of small arboreal lizards inhabiting the tropical and semi-tropical parts of America. The body is slender and more or less compressed; the head is usually long and flattened, superficially resembling in shape that of a crocodile, and is provided with a large fold of skin, or dewlap, on the throat, which is distensible at will, but not inflatable as in *Draco*. The fingers are more or less dilated, enabling the creatures to attach themselves to smooth surfaces.

The CAROLINA ANOLIS, *A. carolinensis*, a common species in Florida, where it goes under the misnomer of “chameleon,” is remarkable for its colour changes. It is most frequently bright green in colour, but may be greenish-

white, grey, or light or dark brown, according to circumstances. At a very high or low temperature, heat is the controlling factor, the lizards at a temperature of below 60° being almost invariably green in colour, while at a temperature of over 80°, dark brown, irrespective of illumination. At intermediate temperatures, however, light and dark influence the changes, as they become green when in the shade, dark brown when basking in the rays of the sun. According to Holbrook, the males seldom meet without a furious battle, resulting in the loss of a tail, or other injuries to one or both of the combatants. Before springing at its enemy the creature remains perfectly still for a short interval, nodding its head many times in succession and distending its dewlap, which becomes of a bright vermilion.

These active little lizards become very tame in captivity, feed from the hand, and, in fact, seem to lose all fear of man. Their cage should be provided with foliage, and sprinkled daily, as they will seldom drink out of a bowl, preferring to lap up the drops which have settled on the leaves.

Basiliscus, containing four species, restricted to Tropical America, are semi-aquatic forms, remarkable, especially in the males, for the very high crests on their heads, backs, and tails, which are covered with scales, and, in the case of the dorsal and caudal crests, are supported by spinous processes of the vertebral column.

According to Gadow they frequent the low branches of trees, especially of those overhanging streams, into which they dive on being alarmed. The high dorsal and caudal crests have often been said to act as a sail when the

creature is swimming, but this statement appears to be a mere fable, not having been confirmed by any reliable person.

Although generally reputed to be exclusively vegetarian, specimens of *B. americanus* and *B. vittatus* at the Zoological Gardens refused the lettuce and fruit offered, feeding entirely on worms.

Sceloporus is a genus of smallish lizards, four to twelve inches in length, popularly known as SWIFTS, on account of the rapidity of their motions. The genus extends from the United States to Guatemala. The body, devoid of dorsal or caudal crests, is short, thick, and depressed, with strongly keeled scales above.

The UNDULATED SWIFT, *S. undulatus*, the commonest species, frequently offered for sale in this country, abounds in the pine forests of the Western States, choosing the bark of trees as its resting-place. Its food in the wild state is said to consist almost entirely of such insects as are found under decayed wood.

Captivity does not usually agree with any of the Swifts, as in confinement they soon become weakly and sluggish, belying the name bestowed upon them on account of their great activity.

Iguana, the type genus of the family, is represented by two species only, which inhabit the forest districts of the greater part of Tropical America.

The body, which is somewhat compressed, is provided, especially in the males, with a much-developed dorsal crest, composed of soft spines. The genus is further remarkable for the extraordinary development of the gular appendage. The tail, which is long, more than half the

total length, is much compressed, in accordance with semi-aquatic habits.

The flesh of these lizards is said to be most excellent eating, and they are consequently much hunted for, the living specimens being brought to market in large quantities, incapacitated through the stretching of the tendons of their hind limbs. As they usually frequent the lower branches of trees, they are easily captured by means of a long rod, at the end of which is a noose, which is passed round their neck, the animals' attention being, in the meanwhile, attracted by the whistling of some concealed person. They are also often captured by dogs, specially trained for the purpose.

The COMMON IGUANA, *I. tuberculata*, reaches a length of over five feet. It is green in colour, speckled or variegated with darker and lighter; a whitish band is constant in front of the arm. The exceedingly long tail is annulated with black.

In its native forests, this lizard lays her eggs, which number up to one hundred, in a hole in the ground, leaving the neighbourhood of water, and retreating further into the forest for the purpose. Having performed these duties, she immediately returns to the locality which she previously frequented, on the boughs near the waters' edge.

This Iguana unfortunately does none too well in captivity, seldom flourishing for more than a year or so, frequently becoming affected by a form of paralysis. The large number of specimens which have passed through my hands were all strict vegetarians, feeding on lettuce, bananas, and grapes; Ditmars states, however, that they

are occasionally not averse to quite young birds, and small rodents.

Metopocerus, which is closely allied to the true Iguana, is represented by a single species, *M. cornutus*, the HORNE*D* IGUA*NA*, which is characterized by a large, conical, horn-like scale on the snout. A dorsal crest and gular appendage are present, as in *Iguana*, but less developed. It is also principally vegetarian, and specially partial to oranges.

The CTENOSAURS, genus *Ctenosaura*, may be distinguished from the latter two genera by their cylindrical tails, which are conspicuously armed with spiny scales, forming whorls.

The BLACK CTENOSAUR, *C. acanthura*, of California and Mexico, is frequently seen in menageries. In this species the dorsal crest is continuous with the caudal, and the tail, which is moderately long, is covered above with alternate rings of large spines and small, smooth scales. The colour of this lizard is usually entirely black, sometimes dark brown or olive, with blackish markings forming cross bands on the body and rings on the tail. The young are green.

Although a ground lizard, the Black Ctenosaur makes its home in the forest, laying its eggs in the holes which it digs at the foot of trees. It feeds on mice, young birds, and earthworms, varying its diet with fruit. Although when first captured it is usually very savage, dealing out blows with its spiny tail and attempting to bite, it soon becomes tame, taking food from the hand.

The SPINY-TAILED CTENOSAUR, *C. erythromelas*, of Mexico, is the New World analogue of the Old World Mastigure, the tail of this animal being short, depressed,

and covered with large broad spines. It is endowed, like many other lizards, with the power of changing colour, the blackish olive of its upper parts, which are mårbled with brick red, passing to a light blue.

The genus *Phrynosoma*, the HORNEO TOADS, as these small, much flattened lizards are often called, inhabit the Southern United States and Mexico; they are covered all over with spines, those at the back of the head being specially developed. These spines are bony processes of the skull, covered with horn, and not, as in the case of the Moloch, merely hollow horny structures. The colour of these creatures is usually grey or light brown, harmonizing in a remarkable manner with the sandy soil upon which they are found.

Dr. Stejneger, who has observed these lizards in their natural environments, states that, in the cedar and pine belts of the San Francisco mountain, the dark colour of the soil and stones covering the surface is exactly matched by the ground colour of the Phrynosomes, while the greenish-grey or orange-coloured markings, which somewhat irregularly adorn their backs, are perfect imitations of the lichens covering the rocks and pebbles among which these odd-looking creatures live. Near the rim of the Grand Canyon of the Colorado, where the ground is covered with minute pebbles of coloured sandstone, which ranges in colour from white to brick-red and dark brown, the specimens are all faithful reproductions of their surroundings. Most remarkable of all, however, are the Horned Lizards of the black lava belt, which is situated north-east of the mountain, for these are black above with light markings of "Naples yellow," changing into



(a)



(b)



(c)

- (a) Tuberculated Iguana, *Iguana tuberculata*.
 (b) Spiny-tailed Iguana, *Ctenosaura erythromelas*.
 (c) Horned Lizard, *Phrynosoma cornutum*.



Giant Zonure, with young, *Zonurus giganteus*.

yellow ochre on the sides, even the gloss of the black lava being imitated.

Although dependant on very great heat during the day-time, when they move about with some rapidity, at night, having retired into the sand, they are able to withstand very severe cold, *Pb. bernandezii*, of Mexico, for instance, being found at an altitude of over 10,000 feet, where, of course, many degrees of frost are registered nightly.

In captivity, unless provided with a very high temperature, they are sluggish, remaining for hours in the same position and refusing their food, which consists of various small insects.

When on the defensive these lizards generally merely flatten their bodies and become quite rigid, giving one the impression of simulating death. A curious fact has, however, been observed in some individuals, such specimens, when alarmed, squirting fine jets of blood from the corner of their eyes to a distance of several feet. Prof. Underwood has given the following account of this remarkable habit: "In examining a specimen, I took occasion to turn him on his back, using a lead pencil for the purpose. The animal resented this treatment, and showed considerable anger, opening his mouth and puffing his body. Irritating the creature still more, he grew more and more enraged, until finally blood spurted from just above his eye, which was fired at least a foot from the animal, as several spots struck my arm considerably above my wrist. After spurting the blood the animal became limp and collapsed, and remained in stupor for some time, and when handled became as dead. After a time, possibly not over five or six minutes, certainly not over ten, the

animal revived and commenced to run about the table. Wishing to know if he would repeat the operation, I commenced to irritate him again in the same manner. After becoming enraged again, it went through the same process, ejecting blood from the same eye as before. He then fell into a similar stupor, and remained about the same length of time, after which he revived. No amount of irritation could possibly produce a third discharge, although the animal showed anger." This habit of discharging jets of blood has been observed on several occasions, and it has been suggested that it may be of use to the lizard in interfering with the clearness of vision of pursuing enemies.

With the exception of one or two species, the Horned Lizards produce their young, numbering up to twenty-five, alive, the horns of the newly born reptiles being as much developed proportionately as in the adults.

The family ZONURIDÆ, which forms a connecting link between the *Iguanidæ* and the *Anguidæ*, resembling the former in the short, thick tongue, and the latter in various cranial characters, offers an example of the gradual reduction of limbs, some species having all four well developed, while in others they are rudimentary or even entirely absent.

In the type genus *Zonurus*, the body and tail are covered with bony plates under the scales, forming longitudinal and transverse series, the horny coverings of which are often produced into spines.

The GIANT ZONURE, *Zonurus giganteus*, a large and formidable member of the family, inhabiting the greater

part of South Africa, attains a length of nearly two feet ; its entire body and tail, and the back of the head are armed with large spines, on which it entirely relies for defence. It lives in dry, rocky districts, retreating into underground burrows at night and during the period of hibernation.

Although the average duration of life of this lizard in captivity may be put down at as much as five or six years, it never becomes at all tame, but, on its cage being opened, dashes about in the wildest manner. It is strictly carnivorous, with a partiality for earthworms.

Pseudocordylus, likewise of South Africa, of which *P. microlepidotus* is the sole representative, may be distinguished from *Zonurus* by the small, flat, and roundish tubercles of the back ; the tail, however, is almost as spinose as in the latter genus.

In *Chamæsauro*, in which the body is long and snake-like, the degeneration of both pair of limbs is progressive, starting with *Ch. ænea*, with both pairs present and half an inch long, and ending with *Ch. macrolepis*, in which the fore limbs are entirely absent and the hind ones almost invisible to the naked eye.

The lizards of the family ANGUIDÆ are not very far removed from the *Iguanidæ*, although differing so much from them in external appearance. They have likewise a short tongue devoid of scale-like papillæ, but its anterior, bifid portion is retractile into a fold in the posterior portion. Unlike the *Iguanidæ*, they are covered with bony plates underlying the horny scales, as in many of the *Zonuridæ*, which differ in the anterior portion of the tongue not being retractile.

This family includes types with well-developed limbs, with reduced limbs, or with no limbs, although vestiges of the pectoral and hip girdles are always present. It includes two divisions : one in which the body is completely surrounded with dermal ossifications, as in our Slow-worm, the other in which a well-developed fold extends along each side of the body, separating the dorsal from the ventral cuirass. This fold is of use in permitting an increase in the calibre of the body, in cases where the dermal armour is particularly rigid, thus allowing for the distension necessitated by voluminous food, or the development of the ova.

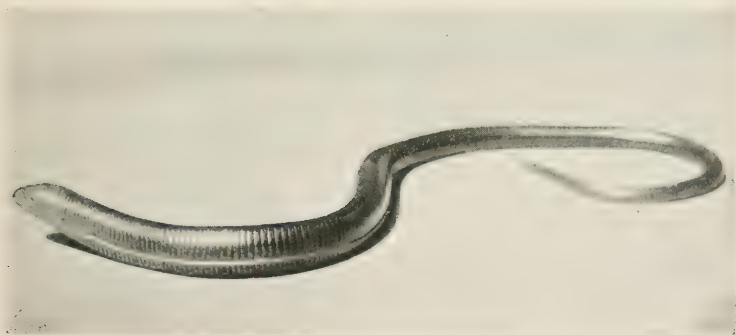
To the first group belongs the genus *Anguis*, of which our British SLOW-WORM, or BLIND-WORM, *Anguis fragilis*, is the sole representative. This snake-like lizard grows to a length of eighteen inches, which is, however, rather exceptional. Although provided with long, sharp teeth, not unlike those of snakes, it is a very gentle creature, never attempting to bite, its chief means of defence residing in the very brittle, long tail, which often remains in the hand of its captor. This harmless and very useful creature, feeding mainly on slugs, is ruthlessly killed by the ignorant, who often regard it as a blind snake, hence its English name of Blind-worm, or the German *Blindschleiche*. Its eyes, however, though small, are well developed and bright, and furnished, as in most lizards, with movable lids, and therefore closed at death, thus contrasting with the large, staring eyes of a dead snake, and accounting for the popular fallacy as to its blindness. Unlike most lizards, and owing no doubt to the nature of its food, the Slow-worm shows a predilection for dampness, crawling about among the dew,



(a)



(b)



(c)

(a) Smooth-backed Zonure, *Pseudocordylus microlepidotus*.

(b) Slow-worm, *Anguis fragilis*.

(c) Glass-snake, *Ophisaurus apus*



The Gila Monster, *Heloderma suspectum*.

or even in rainy weather ; it is nevertheless fond of basking in the sun, and a combination of dampness and sunshine appears to be its ideal condition.

When in good health, it sheds the outer coating of its epidermis whole, as do snakes ; other Anguids, *Gerrhonotus*, for instance, have been observed to do the same. The young, about six to twenty at a litter, are born alive, and are distinguished from the grey or reddish-brown parents by their striking livery : silvery white above, black beneath, with a black streak along the middle of the head and back.

The Slow-worm can be kept for years in captivity if provided with damp moss and plenty of slugs or small earth-worms ; the young will take small spiders and insects, which are usually despised by the adult.

The allies of the Slow-worm, which are provided with well-developed limbs, constitute the genus *Diploglossus*, inhabiting the West Indies and Tropical America.

The *Gerrhonotus* of North and Central America, belonging to the division with a lateral fold, are also lizard-like and lead to the *Ophisaurus*, in which the limbs are absent, or reduced to minute external rudiments of the hind pair.

There are six species of *Ophisaurus*, from North America, Asia, and Europe. The European GLASS-SNAKE, or SCHELTOPUSIK (a Russian name), *O. apus*, has tiny, flap-like rudiments of hind limbs. It is a large creature, reaching a length of three to four feet, and inhabiting the wooded districts of South-East Europe ; its name, Glass-snake, has the same meaning as that of *fragilis* applied to the Slow-worm. It feeds principally upon mice.

The two representatives of the family HELODERMATIDÆ, which is composed of a single genus, *Heloderma*, are the only poisonous lizards, their teeth being grooved, and those of the lower jaw connected with a large poison gland; they inhabit Mexico and Arizona. The head is very large, depressed and, like the elongate body, covered with bony tubercles. The limbs, which are provided with long claws, are, although short, strongly developed. The protusible tongue is thick, fleshy, and bifid at the tip. The tail measures about half the length of the head and body, and is much swollen, especially in *H. suspectum*.

The GILA MONSTER, *H. suspectum*, grows to a length of two feet. Its general colour is salmon-pink, reticulated with purplish brown or black, some of the tubercles resembling coloured beads.

The numerous experiments that have been made with this lizard on small animals, and the several cases of death in man, which have occurred in Arizona, demonstrate beyond all possible doubt the virulence of its poison. Mme. Phisalix, who has conducted experiments on the reciprocal action of the poison of this species and that of our Common Viper, has shown that neither enjoys immunity, and that the latter, injected with Heloderm poison, is stupefied after a few seconds, dying within twenty-four hours, while, when the Viper is made to bite the tail of the Heloderm, the lizard will die about fifty hours later. This lady was herself bitten by the animal while handling it for her experiments, and, in spite of the fact that only a few of the reptile's teeth penetrated the flesh, was laid up in consequence for a period of nearly three months. We can therefore imagine the results that are

likely to follow when all the poison fangs, which number up to fifty, are brought into action.

The Gila Monster inhabits the dry desert regions, feeding on small mammals and the eggs of birds and other lizards. Specimens kept by the writer were fed on eggs and very finely minced-up meat, the mixture being lapped up, after the manner of a dog. Although usually tame and sluggish, allowing themselves to be handled, if seriously annoyed these lizards become very savage, and raise themselves as high as possible on their hind legs, snapping right and left. One of these lizards at the Zoological Gardens has the peculiar, unlizard-like habit of sleeping on its back, the keepers in consequence having their attention constantly drawn to the fact by visitors, who inform them that the Heloderm is dead!

The other species, *H. horridum*, of Western Mexico, is distinguished by its longer and less swollen tail, and by the tubercles of the back being separated by wider granular interspaces. It differs also in its general colour, being black with yellow spots.

The MONITORS, family VARANIDÆ, containing a single genus, *Varanus*, made up of about thirty species, are distributed over Africa, Southern Asia, and Australia. The genus includes amongst its members the largest of all lizards, some being said to attain a length of twenty feet. Characteristic of them is their very long tongue—as deeply forked as that of a serpent, and likewise retractile into a basal sheath—and their long neck. The limbs are strongly developed and provided with powerful claws. The body is covered with small tubercles above, with squarish scales,

arranged in transverse series, below. The tail, which is always very long, is rounded in terrestrial and arboreal species, compressed and sharp-edged above in those frequenting the water; in these it is made use of as a weapon of defence, the lizards lashing out vigorously with this organ at their enemies. In conformity with the semi-aquatic life of many of them, the nasal opening leads into a cavity situated on the snout, the aperture closing and retaining a certain quantity of air, thus enabling the lizard to remain for a considerable time under water. The parietal, eye-like organ, alluded to in the chapter on *Sphenodon*, is less degenerate in the Monitors than in any other lizards.

With the exception of the LAND MONITOR, *V. griseus*, all these creatures are good climbers, ascending to the top of trees to plunder the nests of birds. This land Monitor, a comparatively small species, inhabiting North Africa and South-West Asia, seldom exceeding four feet in length, is greyish-yellow in colour, harmonizing with the sand of the desert in which it lives.

The NILE MONITOR, *V. niloticus*, and the WHITE-THROATED MONITOR, *V. albigularis*, are two African species; the former is found all over the continent with the exception of the north-western part, while the latter is confined to South and South-Eastern Africa. The Nile Monitor is very abundant on the banks of the Upper Nile, where it searches for the eggs and young of crocodiles, and is therefore, although much feared by the natives, regarded with the very greatest respect. The general colour is dark brown, or black above, with yellow spots on the back and limbs. In the young the yellow markings are ocellar and



(a)



(b)



(c)

- (a) Grey Monitor, *Varanus griseus*.
 (b) The Banded Monitor, *Varanus salvator*.
 (c) Bengal Monitor, *Varanus bengalensis*.



Lace Monitor, *Varanus varius*.



White-throated Monitor, *Varanus albigularis*.

very elegantly disposed in cross bars. *V. albigularis*, which has a larger head and shorter neck, and which is somewhat less aquatic than *V. niloticus*, is greyish-brown above with large round, yellow, dark-edged spots, arranged in transverse series on the back.

The BANDED MONITOR, *V. salvator*, one of the largest species, attaining a length of nearly nine feet, inhabits Ceylon, Bengal, South China, Burma, and the Malay Peninsula and Archipelago. The general colour is brown above, with yellow spots and bands on the sides of the body. It is found in marshy localities or in the branches of trees overhanging water, preying upon small mammals, as well as birds and their eggs. When disturbed it dives from a considerable height into the water below. The flesh of this species is appreciated by the lower caste of Hindoos, who capture these lizards by digging them out of their burrows on the banks of the rivers. As in the case of the Iguanas, they are also occasionally hunted down by dogs, specially trained for the purpose.

The Singalese, by whom the lizard is regarded as an omen of ill-fortune, believe that its fat, when externally applied, is a cure for various skin diseases, but that when taken inwardly it is highly poisonous. In India some of the Monitors, and especially the conspicuously marked young, are regarded by the natives as very venomous, and go by the name of "Biscobra."

In Australia the two commonest forms are the LACE MONITOR, *V. varius*, and GOULD'S MONITOR, *V. gouldii*, both attaining a length of five to six feet. The head scales in the former species are large, while in the latter they are quite small. Gould's Monitor is not nearly so arboreal as

the Lace Monitor, keeping on the ground when alarmed, and taking refuge in holes in the earth, never endeavouring to climb up a tree.

Until quite recently *V. salvator* and *V. giganteus* of Australia, which both attain a length of nine feet, were considered to be the largest living lizards. A monitor recently described from Comodo, a small island between Flores and Sumbawa in the Malay Archipelago, however, appears to be of exceptional dimensions, greatly exceeding in size any previously recorded species. Mr. Van Steyn, when Civil Administrator of the island of Flores, being informed of the existence of a monitor of exceptional size, said to attain twenty-three feet in length, in the island of Comodo, resolved to obtain further particulars of this animal, and proceeded to the island to, if possible, obtain a specimen. He was only able to secure one seven feet long, but at a later date another thirteen feet long was shot, and has been described under the name of *Varanus komodensis*. It is said to live exclusively on land, making great holes under the stones, under which it always remains at night.

A fossil monitor, *V. priscus*, attained a size at least as large as the reported gigantic specimen of this newly discovered reptile, and, in fact, it is not altogether impossible that the two may be closely related, if not identical.

Most Monitors become very tame in captivity, taking the eggs, to which they are very partial, from the hand; an individual living some years ago in our gardens would eat as many as eight hen's eggs in succession, swallowing them entire, the shell being crushed by the contraction of the muscles of the neck.

In all the species of the strictly Old World lizards of the family LACERTIDÆ, the limbs are well developed, the tail is long and fragile, and the head is covered with bony plates and large symmetrical, horny shields. The scales of the back may be large and strongly keeled, or merely granular. The lower eyelid in some of the species, especially of those inhabiting sandy districts, is protected by a transparent disc, enabling the lizards to see when the lids are closed.

The only two lizards inhabiting the British Isles, namely, the COMMON LIZARD, *L. vivipara*, and the SAND LIZARD, *L. agilis*, are typical members of this family. The Common Lizard, which seldom exceeds six inches in length, is distributed over the greater part of North and Central Europe, and is the only reptile inhabiting Ireland. It differs from the other species of the genus in bringing forth its young alive, these being born in litters of from five to a dozen. The newly-born lizards, which measure under an inch in length, for the first fortnight or so, subsist on the remains of the yolk in their abdomen. This familiar reptile, the general colour of which is light brown or yellowish-brown, with frequently a dark line down the middle of the back, and another edged with yellow on the sides, is usually found sunning itself on heaths or in meadows in the neighbourhood of water, and captive specimens, unlike its other relatives, have to be kept in comparatively damp surroundings.

The Sand Lizard, which is a very local creature with us, confined to sandy heaths, is abundant in some parts of Dorsetshire and Hampshire, and between Farnham and Hindhead, reappearing on the sand dunes in the neigh-

bourhood of Southport in Lancashire. On the Continent it is generally distributed over the Northern and Central parts. It is larger and more heavily built than the Common Lizard, and, in spite of its specific name, not nearly so active. The female is brown, with numerous conspicuous black-and-white eye-spots on the back and sides, while the male, especially in the spring, is of a most beautiful emerald green on the sides and belly, and is consequently continually being confounded with the GREEN LIZARD, *L. viridis*, of the Channel Islands and Central and Southern Europe. The latter, which reaches a length of nearly a foot, is entirely green above, with a blue throat in the male of the typical form. Although seldom living for much more than a year in captivity, it does well in this country if given its freedom, a number of specimens imported some years ago by the Hon. Cecil Baring, and let loose on the small island of Lambay, off Dublin, having maintained themselves and multiplied. The movements of these lizards during the warmer parts of the day are bewilderingly rapid, and this, combined with the fact that bramble bushes or gorse usually form their hiding-places, at least in the Channel Islands and Brittany, makes their capture no easy matter.

The eggs, about half a dozen in number, laid in April or May, are hatched about a month later.

The variety *major* of this species, which inhabits Dalmatia, Turkey, Greece, and Asia Minor, attains a length of fifteen inches; it differs from the typical form in a larger number of scales round the body, and in the throat never being blue, but always yellow, like the rest of its under-surfaces. The young also differ in colour, being

olive, with three or five yellowish longitudinal streaks, instead of four, the lowermost of which extends to the hind legs, and may be replaced by a series of round spots.

The EYED LIZARD, *L. ocellata*, a closely allied, but larger and bulkier creature, a native of the South of France, North-West Italy, Spain, and North-West Africa, is still more handsome, the green ground colour being relieved with a black and yellowish network, while the sides are ornamented with large dark blue eye-spots, the latter having a tendency to disappear in the variety *pater*, the North African form. This variety, the most frequently imported to this country, like the Green Lizard, seldom thrives for any lengthy period in captivity. The typical form, however, which fetches a higher price in the market, is fairly hardy, living for several years in roomy quarters, hibernating towards the end of October, reappearing the following spring. It feeds on worms, mice, and small birds.

The WALL LIZARD, *L. muralis*, is a widely distributed species, ranging over the greater part of continental Europe and the islands of the Mediterranean, as well as North-West Africa and South-Western Asia. It may be divided into at least thirty more or less distinct varieties, certain of which differ so much from the typical form inhabiting Jersey and Central and Western Europe, that they are regarded by some authors as valid species. They are, however, so completely connected by intermediate forms as to render their precise definition impossible.

The typical Wall Lizard is of the same size as our common English lizard, and of grey or brown colour, with darker markings. It often occurs in great numbers on

rocks and old walls, basking in the sun and dashing away into holes or crevices with extreme rapidity when approached. Italy and the east coast of the Adriatic produce beautiful varieties (*campestris*, *serpa*, *fiumana*), some individuals being of a bright green colour, with or without black-and-white spots, streaks, or markings, and often reaching a much larger size than the typical form.

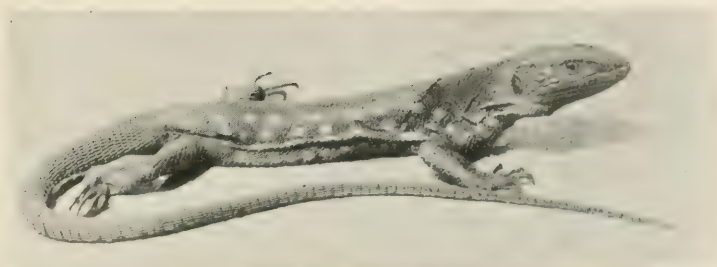
On some small islands in the Mediterranean and the Adriatic all the lizards are entirely black above, lapis blue, or black beneath, such as the variety *cærulea* from the Faraglioni rocks near Capri, and *lilfordi* from the Baleares; in the variety *filfolensis*, from the Filfolia rock near Malta, the colour is also black, but usually relieved with small green spots, remains of the ground colour of the Maltese Lizard, from which it is derived. One of the best marked forms is the variety *bedriagæ*, which occurs at a considerable altitude in Corsica; it is remarkable for its much flattened head and body, and for its large size, reaching a length of over three inches, without the tail, which is about twice as long as the body.

All who have tried to catch Wall Lizards with the hand must wonder how such numbers can be procured by dealers all over Europe. This is done by means of a horsehair at the end of a flexible rod; the hair is tied in a noose at the end, which the practised Italian and Dalmatian youths manage to pass round the neck of the lizard basking in the sun; a rapid pull and the lizard is secured.

With the exception of the variety from the Filfolia rock, of which specimens at the gardens are still flourishing at the time of writing, after three years of captivity, the Wall Lizard confined to a small cage does not as a rule live long,



(a)



(b)



(c)

- (a) Green Lizard, *Lacerta viridis*.
(b) Eyed Lizard, *Lacerta ocellata*.
(c) Sand Lizard, *Lacerta agilis*.

(a)



(b)



(c)



(a) Wall Lizards, *Lacerta muralis*.
(b) Canary Island Lizard, *Lacerta galloti*.
(c) The Plated Lizard, *Gerrhosaurus major*.

becoming very soon emaciated, in spite of a seemingly healthy appetite. In the autumn of 1911 I let loose some hundreds of specimens of Wall Lizards at the back of our Tortoise House, which is covered with bark, in order to ascertain whether these creatures would thrive better in more home-like surroundings. The experiment was most successful, for although, as was only to be expected, a number escaped, the majority evidently found their quarters most suitable, settling down and breeding, the newly born lizards being first observed the following June.

GALLOT'S LIZARD, *Lacerta galloti*, of the Canary Islands, is a large species, attaining a length of a foot. It is very dark olive or even black above, with greenish spots. This lizard is much addicted to burrowing, and is fond of water, and in the latter respect differs from other members of the genus.

Acanthodactylus of North Africa and South-Western Asia is closely allied to *Lacerta*, but may be recognized by its fringed digits.

Some of the species of this genus were mummified by the ancient Egyptians, and kept as charms in small wooden or metal boxes, the top of which had in relief a representation of the lizard preserved inside.

The family TEIIDÆ, which is restricted to the New World, is made up of forty-five genera, and about one hundred and fifty species. From the Lacertids, which many of the smaller forms externally resemble, they may be distinguished by the teeth, these not being hollow at the base, the new ones developing in small sockets at the base of the old ones. In some of the higher forms the

teeth are inserted almost on the parapet of the jaws, while in others they are attached more distinctly to the inner side, the dentition in many cases being exactly intermediate between the acrodont and the pleurodont.

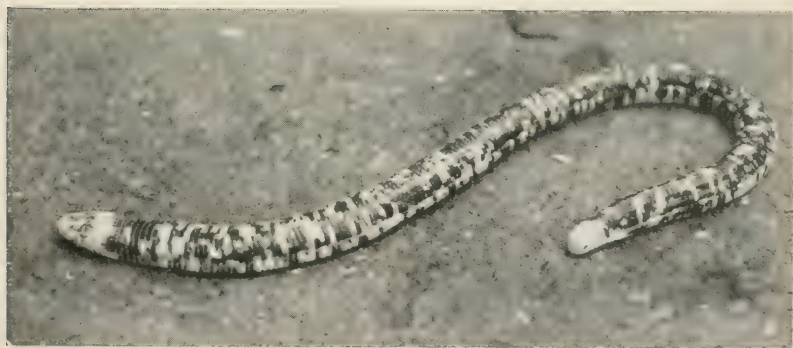
These lizards show great variation in form and scaling : some have a Monitor-like appearance, and are arboreal, others are strictly terrestrial, and more like typical lizards, while in a few cases the limbs have become rudimentary, such forms approaching in general appearance the burrowing *Amphisbænids*.

The COMMON TEGUEXIN, *Tupinambis teguexin*, inhabiting the forest districts of Trinidad and tropical South America, from the Guianas to Uruguay, attains a length of nearly four feet. Its very large head, covered with symmetrical shields, is scarcely distinct from the neck, the latter measuring up to seven inches in circumference. The cheeks of the animal are provided with large pouches, which are much inflated when the lizard becomes angry. The tail is long and rounded and made use of as a weapon of defence, as in the Monitors. The ground colour is olive brown above, marbled or transversely barred with black, and with a series of more or less distinct rows of lighter spots; the under-surface is yellowish with transverse bands.

The RED TEGUEXIN, *T. rufescens*, which is confined to the Argentine, is very similar to *T. teguexin*, but with all the scales very much smaller. The coloration is reddish above, with brown transverse bands; the lower parts with more less distinct irregular transverse dark spots. The largest specimen recorded, one at present living in our Zoological Gardens, measures three and a half feet in length.



Red Teguxin, *Tupinambis rufescens*.



Sooty Amphisbaena, *Amphisbaena fuliginosa*.

(a)



(b)



(c)



- (a) Common Skink, *Scincus officinalis*.
(b) Eyed Skink, *Chalcides ocellatus*.
(c) Blue-tongued Skink, *Tiliqua scincoides*.

The Teguexins, the largest of the American lizards, are similar in their habits to the Monitors, likewise feeding principally on eggs and small mammals; they are easily tamed, captive specimens soon allowing themselves to be handled, and they may be let loose in a room without danger of their attacking or of any difficulty being experienced in recapturing them.

The lizards of the family GERRHOSAURIDÆ, inhabiting Africa and Madagascar, are intermediate between the typical lizards and the Skinks, agreeing with the former in the structure of the skull and the presence of femoral pores (pits producing a secretion, and forming a series under each thigh), and with the latter in the body being protected by bony plates, underlying the scales. As in the Skinks the limbs may be fully developed or rudimentary.

In the genus *Gerrhosaurus*, of which *G. major*, attaining a length of two feet, is the largest representative, a very marked lateral fold, similar to that of Glass Snakes, is constantly present.

The SKINKS, family SCINCIDÆ, cosmopolitan lizards, of which the greater number occur in Australia, S. Asia, and Africa, have the body much depressed and covered with usually roundish and smooth scales, underlain by bony plates. The limbs of the members of this family are undergoing a process of reduction, and a single genus may show every stage from the fully developed five-toed type, to such as have these organs almost entirely absent, the degree of development of the limbs, which is often employed for the distinction of the genera in other families, being in these lizards of not more than specific value.

The majority of Skinks frequent dry, arid districts, being specially adapted for living in the sand; some, however, live in herbage, and a few are arboreal.

The COMMON SKINK, *Scincus officinalis*, of the Sahara, called Sand-fish by the Arabs, moves with marvellous rapidity in the sand, its wedge-shaped snout and its flattened, fringed digits being specially suited to the purpose. It is further characterized by its body being



FIG. 4.—Hind legs of Skinks, to show gradual abortion.

- | | |
|-----------------------------------|---------------------------------------|
| a. <i>Chalcides ocellatus</i> . | b. <i>Chalcides mionecton</i> . |
| c. <i>Chalcides tridactylus</i> . | d. <i>Lygosoma lineopunctulatum</i> . |
| e. <i>Lygosoma guentheri</i> . | |

(After B.M. *Guide to Reptiles*.)

angular on the sides of the much flattened belly. The colour of the upper surfaces is pale yellowish, with frequently dark brown, mauve, or purple transverse bars; the lower surfaces are uniform white. This handsome lizard unfortunately requires an extremely high temperature, such as it is practically impossible to supply it with in a vivarium, and consequently lives but a few months under captive conditions.

The OCELLATED SAND SKINK, *Chalcides ocellatus*, another

common species, brown in colour, with black and white ocellar spots, likewise of North Africa, but also found in Sardinia, Sicily, and South-Western Asia, is less burrowing in its habits, and much more easily kept in confinement. It is not consistent in its breeding habits, for, although usually viviparous, it has on some occasions been observed to lay eggs in captivity, these having a rough, parchment-like shell.

This lizard has short but fully developed limbs, provided with five digits. Other members of the genus, however, show various stages in the reduction of these organs, the digits in *C. mionecton* numbering four, in *C. lineatus* and *C. tridactylus*, three, while in *C. guentheri* each limb is reduced to a minute undivided rudiment.

Some of the species of the Australian genus *Egernia*, the majority of which have the scales thick and bony, are remarkable for their spinose tails, recalling in CUNNINGHAM'S SKINK, *E. cunninghami*, and still more in STOKES'S SKINK, *E. stokesii*, and the SPINY-TAILED SKINK, *E. depressa*, the state of things mentioned when dealing with the Mastigures and some of the Ctenosaures. All the members of the genus are hardy, subsisting on fruit, insects, and worms.

The GIANT SKINK, *Tiliqua scincoides*, or BLUE-TONGUED LIZARD, as it is often called on account of the deep purplish-blue colour of its tongue, also of Australia, is the largest member of the Skink family, some specimens attaining a length of nearly two feet, of which the thick, cylindrical tail accounts for a little less than half. The smooth, shiny, and much flattened body is yellowish-brown above with dark transverse bands, as in the Common Skink, to which,

but for its size and blunt snout, it bears a striking resemblance. Unlike the North African species, it requires only a moderate amount of heat, living for many years in confinement, and in this respect is one of the most satisfactory of all reptiles; a recently defunct specimen in the Zoological Gardens lived for just over thirteen years in quite a small cage. It is both carnivorous and herbivorous, with usually a preference for bananas and earthworms.

The STUMP-TAILED LIZARD, *Trachysaurus rugosus*, yet another native of Australia, may be easily recognized by its elongate, thick body, covered with enormous rough scales, suggestive of the cone of a fir-tree, and by its short, stumpy tail, superficially resembling the animal's massive head. The colour above is black, mottled with yellow, entirely yellow below. It feeds on fruit, meat, worms, lizards, and snakes, its great partiality for the latter resulting in its being held with a certain amount of respect by the Australian colonist. The animal, which frequents dry, sandy localities, and is often met with on sandy roadways, is exceedingly sluggish in its movements, refusing even to get out of the way of passing vehicles, merely opening its mouth widely as these approach, and its capture, in consequence, is a matter of the greatest ease. Although usually doing well in captivity, this lizard, which at first is inclined to bite, but soon becomes amenable, is subject to a peculiar wasting disease, from which it seldom recovers, the symptoms taking the form of running at the eyes and slight foaming at the mouth; the disease seems to be highly infectious, and in the event of several specimens sharing a cage, the isolation of the patient is an absolute necessity, for otherwise its companions would all become



Cunningham's Skink, *Egernia cunninghami*.



Stump-tailed Lizard, *Trachysaurus rugosus*.

affected within a very short time. The Stump-tailed Lizard is viviparous, and is the only lizard which brings forth but a single young at birth, the newly born reptile being remarkable for its size—half that of its parent.

With the exception of a single representative, the lizards of the family AMPHISBÆNIDÆ are entirely devoid of limbs; they have the eyes concealed under the skin, which is quite soft and divided into regular segments, have no ear, and are provided with a short, stumpy, more or less prehensile tail.

All the Amphisbænas are burrowers, boring long, narrow galleries in the earth, in which they are able to progress both backwards and forwards in a worm-like fashion; on the ground they move in a straight line by means of vertical undulations, and not by lateral movements, as in the case of all other limbless reptiles. The great majority live entirely on earthworms, a few frequenting ants' nests, feeding on the insects and their eggs.

Lepidosternum microcephalum and *Anops kingii*, both inhabitants of Brazil and the Argentine, have been observed to lay eggs, and there is no reason to suppose that the other members of the family are not oviparous. Of the seventy species which have been described the greater number inhabit South America and Africa.

Blanus cinereus, the only European species, similar to a big earthworm, is not uncommon in certain parts of Spain and Portugal.

The CHAMELEONS, family CHAMELEONTIDÆ, differ so much from other lizards that they are often placed in a special sub-order—the RHIPTOGLOSSA. The chief differ-

ences reside in the large eyes, covered by a thick eyelid, pierced with a small central opening for the pupil, and movable independently, turning in every direction; in the fingers and toes, which are united in two bundles opposable to each other to form a grasping organ, with two digits on one side and three on the other; and in the tongue, which is club-shaped, sheathed at the base, sticky at the end, and projectile through the action of special muscles to a length exceeding that of the creature's body, an

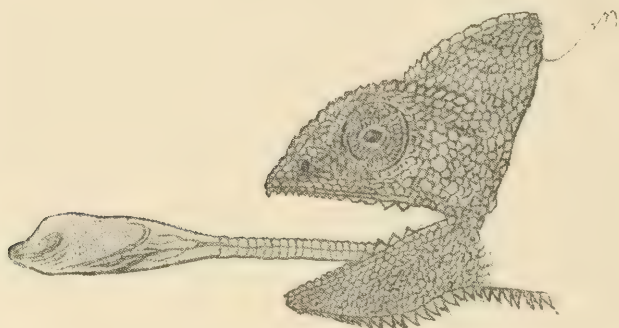


FIG. 5.—Head of *Chameleón calcaratus*.

(After Boulenger.)

adaptation for catching the insects on which the lizard feeds. The head as a rule forms a bony casque, surmounted with crests or tubercles, while the snout of the males, in some species, is provided with long and pointed horny or bony appendages, which, it has been suggested, may be of use during the breeding season on the assumption that they fight amongst themselves for the possession of the females. The compressed body and very prehensile tail are covered with granules or tubercles; dorsal and ventral crests are sometimes present.



(a)



(b)



(c)

- (a) Common Chameleon, *Chamaeleon vulgaris*.
 (b) Lobed Chameleon feeding, *Chamaeleon parvilobus*.
 (c) Warty Chameleon, *Chamaeleon verrucosus*.



Dwarf Chameleon, *Chamaeleon pumilus*.

There are in all about sixty different kinds of Chameleons, about one-half occurring in Madagascar and the neighbouring islands, the other half in Africa and Arabia; India and Ceylon yield a single species, as does Europe, *Chameleon vulgaris*, occurring in the southernmost parts of Spain. Although the majority are of small size, attaining a length of about ten inches, two species, *Ch. verrucosus* and *Ch. pardalis*, both of Madagascar, grow to a length of over two feet.

These lizards are, of course, proverbial for the facility with which they change colour, a faculty common to many others, but which is, with the possible exception of those of the genera *Calotes* and *Agama*, more striking in the Chameleon than in any other reptile. They do not, as is commonly supposed, directly assume the colour of their environments, the changes being entirely due to light, temperature, and emotions, the colour of their bodies assuming a darker hue when exposed to strong light or abnormal heat, and becoming pale when in the dark or at a low temperature.

Most Chameleons are oviparous, laying a great number of eggs in a hole previously scraped out in the ground, and which hatch some four to six months later, according to the species and to the climatic conditions. They are strictly arboreal; *C. namaquensis* of South Africa, however, which is specially adapted to "Karoo" life, possessing stouter limbs, is quite active on the ground; it is brown in colour, showing no trace at all of the prevailing green tints of other forms.

The COMMON CHAMELEON, *C. vulgaris*, of Southern Spain, Syria, and North Africa, being particularly abundant

in Morocco, whence the majority of imported specimens are received, attains a maximum length of about ten inches; it has the casque strongly raised posteriorly, and is provided with a flap of skin on each side of the back of the head. The tail is a little shorter than the head and body in the Western specimens, a little longer in the Eastern. The colour is usually dark olive with several series of pale spots along each side.

This lizard is very difficult to keep for any length of time in confinement, for, although it may feed voraciously on small insects and meal-worms during the warm months, it will seldom do so in the winter, refusing to hibernate as is its custom in its native land, and, as the imported specimens are only received late in the summer, three or four months averages their length of life in this country. As in the case of many other arboreal lizards, it will not drink out of a dish, but licks up the drops of water which have settled on the leaves. Forcible feeding, so frequently inflicted on starving specimens, is of no avail, merely hastening their death. Some individuals are very quiet, others more irascible, opening their wide mouth in a very threatening attitude, and, although their teeth are small, they are able to inflict a painful bite owing to the strength of their jaws.

The SMALL-LOBED CHAMELEON, *C. parvilobus*, which has a wide distribution in South and West Africa, and which is very frequently imported to this country, may be distinguished from the common species by having the occipital lobes very small in size and in the casque being only feebly raised posteriorly; it likewise does not flourish in captivity.

The DWARF CHAMELEON, *C. pumilus*, of South Africa, which grows to a maximum length of only five inches, and is characterized by a much serrated crest along its back and tail, and another formed of compressed lobes along the throat, is the only form which keeps well in captivity, feeding throughout the winter. Owing to its small size, and its comparatively feebly developed powers of changing colour, from a show point of view it is not nearly so attractive as the two previously mentioned species. It is one of the species which brings forth its young alive, producing about a dozen fully formed young in the autumn. The period of gestation in this lizard is extremely lengthy, as a specimen kept by a correspondent of mine brought forth a brood of six young after nearly thirteen months of solitary captivity.

CHAPTER V

OPHIDIA—SNAKES

As previously mentioned when dealing with the lizards, the chief peculiarity of snakes resides in the absence of a solid union between the branches of the lower jaw, the two halves being connected by an elastic ligament, allowing these creatures to dilate their mouths to a very considerable extent, and which, in combination with the mobility of the upper jaw, and the movably attached ribs, enables them to swallow prey of a much larger size than would otherwise be possible. The eyes, which may be rudimentary or large, with a round pupil in the case of diurnal species, and a vertical, or occasionally a horizontal one, in the case of the more nocturnal, are entirely devoid of movable lids, the eyeball being covered with a transparent disk. No snake has ear-openings, and the sense of hearing is consequently only feebly developed. Although rudiments of hind limbs are present in a few families, snakes are practically limbless, moving their elongate bodies by lateral undulations. The ribs have often been stated to be the chief agent of progression, but when we consider the ease and rapidity with which limbless lizards enclosed in a bony armour are able to move, we cannot help thinking that their importance has been somewhat exaggerated,

although of undoubted use for the purpose of climbing and of slow crawling on rough ground.

Snakes have their entire head and body covered with scales, the disposition of which are made great use of in their classification; those of the head may be either large and symmetrical, or small and irregular in shape, and there may be, in addition, erect, horn-like appendages on the snout or over the eyes. The scales of the back, which most frequently overlap and are arranged in oblique transverse series, may be perfectly smooth or provided with keels; on the undersurfaces they are replaced by broad transverse shields, which are usually disposed singly on the belly and in pairs on the tail. The tongue, which is deeply forked and retractile into a basal sheath, is a highly developed sensory organ, acting as a feeler. The jaws are provided with long, sharply pointed, often needle-like teeth, which are frequently shed, but soon replaced by reserve ones. In the harmless species these are all perfectly smooth and solid, while in the poisonous species they are either grooved or canaliculated, and connected by a duct with a poison gland, situated on each side of the head, behind the eye, but which sometimes is produced along the side of the body. The poison secreted by the gland is conveyed through the duct to the base of the fang through the compression of the temporal muscles, when the snake opens its mouth. Some snakes are able to discharge the venom without actually biting, but by shooting the poison from their mouths, often to a considerable distance, such snakes being popularly known as "spitting snakes."

Although the idea is prevalent that the great majority

of snakes are venomous, the reverse is in reality the case, for of the couple of thousand or so different species, barely one-third are endowed with poison glands, and of these the bite of certainly not more than one hundred and fifty could possibly produce death in man.

Poisonous snakes are classified into the following three divisions—

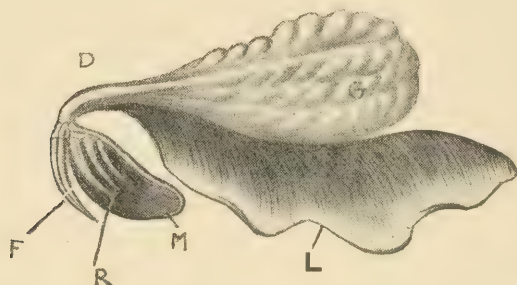


FIG. 6.—Poison-gland and Fangs of Cobra.

- L.* Lobe of the gland.
- D.* Poison-duct.
- F.* Fang attached to maxillary bone.
- G.* Gland.
- M.* Capsule of mucous membrane surrounding the fangs.
- R.* Reserve fangs.

(After Fayrer.)

- I. The **OPISTHOGLYPHS**, in which the poison fangs are fixed to the posterior extremity of the bone of the upper jaw.
- II. The **PROTEROGLYPHS**, in which the fangs are situated in front.
- III. The **VIPERS**, in which the large fangs are attached to a much shortened vertically movable maxillary bone.

The poisonous properties of the Opisthoglyphs are, with one or two exceptions, not nearly so highly developed as

in the Proteroglyphs, their bite in many cases being merely sufficient to paralyse the small animals upon which they prey.

The poison fangs, like all the other teeth, are shed and replaced at short intervals, and, therefore, in the case of specimens kept in confinement, little is gained in their removal. The construction of the fang differs considerably, the groove being in some cases clearly visible externally, the edges not being united, while in others it is entirely obliterated, such fangs being improperly termed hollow. Their size is no criterion as to the venomous nature of the snake, for in some in which the poison is most active they are of quite small size, while the reverse is the case in others. A careful inspection of the teeth is the only way of ascertaining whether a snake is poisonous or not, for from their external appearances the venomous species cannot always be distinguished from the harmless, except by the expert, and, although a number of Viperine snakes have large and flat triangular heads, some of the most deadly Colubrines and even Viperines have them small and narrow. Many of the harmless kinds, by their Viperine and sinister appearance, are often regarded as highly dangerous.

The destruction of human life by snake bite is perfectly astounding, upwards of 100,000 deaths being annually attributed to this cause, India and Brazil alone each accounting for upwards of 20,000 every year.

When a person is bitten by a venomous snake the poison enters the circulation through the blood vessels, and the effects vary according to the creature's poisonous properties and to the rapidity with which the poison enters the

circulation, being almost instantaneous when discharged directly into an artery. The bite usually brings about lethargy and extreme exhaustion, followed by general paralysis of the nervous system, and in many cases entire cessation of respiration. In the Vipers, however, the poison acts more on the circulatory than on the nervous system, producing local hæmorrhage.

Enormous numbers of suggestions have been made for the treatment of snake-bite, which it is quite unnecessary to mention here. The prevention of the absorption of the venom should be the only consideration of the person bitten, and for this purpose a ligature should be placed, immediately after the infliction of the bite, on the limb, a few inches above the wound. As much of the poison as possible should then be removed by making a deep incision at the place of the bite, which should be cleaned out with some strong antiseptic solution. If this treatment could always be carried out with promptitude by those bitten, deaths from snake-bite would be a rarity. Alcohol, which is often prescribed, if taken in moderate quantities, may be of some use in stimulating the heart, but if taken very freely, as is generally the case, the effect is the exact opposite. Walking the patient up and down when in a state of collapse merely produces further exhaustion, and is likewise not to be recommended.

Some years ago Dr. Calmette, of Lille, was able to show that an animal treated for a considerable length of time with graduated injections of the venom of snakes yielded a serum which had an antitoxic effect towards that poison. At a later date he produced a serum which he claimed was, when injected in certain quantities, a cure against the bite

of the majority of snakes, but which Martin and Lamb were able to show was merely specific, and useless for poisonous snakes generally, the serum prepared from the Indian Cobra, for instance, having no neutralizing effects on that of the closely allied Hamadryad. The practical use of these anti-serums is, therefore, beset with much difficulty, for the person bitten often sees but a glimpse of the snake which has inflicted the bite, and even should he be able to do so, he is generally unable to identify the species.

Among the measures recommended in the State of Sao Paulo for the destruction of poisonous snakes is the protection of a recently discovered, seven-foot-long Opisthophlyx, but practically harmless, snake, *Rhachidelus brazili*, which feeds entirely on other snakes, and which has been found to be immune to the poison of the dangerous species of that country. As it devours the largest rattlesnakes and fer de lances, notices are issued all over the country recommending its protection. Although all snakes are to a certain extent immune to their own poison, I have on more than one occasion observed captive specimens in ill-health to succumb to the bite inflicted by companions of their own kind.

Snake charmers are to be met with in many parts of the world, and especially in India, where the Cobra, with its spectacle-shape marking on its hood, is commonly kept by these people. Sometimes the fangs of the snakes have been previously extracted, in other cases not, and the immunity of the best snake men is attributed to successive and graduated inoculations.

Snakes vary greatly in form and habits in accordance with their mode of life. They may be roughly divided

into five groups, which pass into one another through intermediate forms. They are—

1. **BURROWING SNAKES**, which live underground, feeding on earthworms and insects. They have usually a very small head, which is not distinct from the neck, a small mouth, not very expansible, a short tail, and a cylindrical body. They are mostly harmless.

2. **GROUND SNAKES**, which live above ground and seldom climb or enter water. They are the typical snakes, represented by poisonous as well as non-poisonous species.

3. **TREE SNAKES**, expert climbers, spending most of their life in bushes or trees. They may as a rule be recognized by their slender form, their long and sometimes prehensile tail, and by the ventral shields being frequently angulate on the sides. As in the last group they may be poisonous or harmless. Their food consists mainly of birds, lizards, and tree-frogs.

4. **FRESH-WATER SNAKES**, which have the nostrils situated on the top of the snout. They feed almost entirely on frogs and fish. All are more or less harmless to man.

5. **SEA SNAKES**, which, in addition to having superior nostrils, have strongly compressed, rudder-shaped tails. They are all highly poisonous.

Some tree-snakes, *Chrysopelæa* in particular, are known as “flying-snakes,” from their habit of parachuting from tree to tree, the body being kept quite rigid during flight. Shelford, who has investigated this behaviour, states that the ventral surface between the lateral keels, which act as hinges, can be drawn inwards, so that the snake becomes deeply concave along the ventral surface; at the same time there is a flattening of the body. During this muscular

contraction the snake is like a piece of bamboo longitudinally dissected, and is buoyed up in such a manner as to explain the animal's parachute-like descent.

Many snakes, when irritated, inflate their necks. In the Cobras, in which this power is highly developed, the expansion is supported by the front ribs, which are longer than those behind.

As in the case of Lizards, snakes are in the habit of periodically changing their "skin," the outer layer of the horny epidermis being cast entire, with the exception of very large specimens. The animal, a week or so before shedding, refuses food, becomes languid, and, as the eyes become covered with an opaque film, it appears almost blind. The "skin," which is turned inside out in the process, is got rid of by the snake rubbing itself against rough surfaces, and therefore, in the case of captive specimens, their cage should be provided with rockwork, bark, or branches, to assist them in the operation. The periods elapsing between each moult, as may be seen from the following records, relating to the frequency in a number of healthy specimens in our Zoological Gardens, varies considerably according to the individual.

(a) RETICULATED PYTHON, *Python reticulatus*.

Shed on May 11, July 31, September 14, November 4, January 24, March 14.

(b) RETICULATED PYTHON, *Python reticulatus*.

February 26, March 21, June 2, August 3, October 30, November 4, January 26.

(c) INDIAN PYTHON, *Python molurus*.

June 14, December 1, March 9, April 26.

- (d) INDIAN PYTHON, *Python molurus*.

July 31, September 2, February 19, May 19.

- (e) BOA, *Boa constrictor*.

November 8, December 30, April 15, August 2, October 12.

- (f) BOA, *Boa constrictor*.

June 14, September 14, November 19, March 28, May 29.

- (g) BOA, *Boa constrictor*.

April 15, August 2, October 12, December 31, March 28.

- (h) BOA, *Boa constrictor*.

May 24, November 8, March 15, May 3.

- (i) CHICKEN SNAKE, *Coluber obsoletus*.

May 7, September 25, December 16, April 14.

- (k) MOLE SNAKE, *Pseudaspis cana*.

May 25, July 5, September 13, December 1, February 9, May 22.

- (l) INDIAN RAT SNAKE, *Zamenis mucosus*.

July 25, August 9, September 25, October 12, November 18, January 3, March 15, May 9, July 2.

- (m) INDIAN COBRA, *Naia tripudians*.

February 2, April 26, July 12, October 8, November 21, December 28.

- (n) BLACK AND WHITE COBRA, *Naia melanoleuca*.

July 27, September 5, November 19, February 4, April 2, June 21.

- (o) CAPE VIPER, *Causus rhombeatus*.

May 31, September 13, November 18, December 17, March 14.

(p) HORNED VIPER, *Cerastes cornutus*.

June 20, November 7, January 28, March 6.

(q) GABOON VIPER, *Bitis gabonensis*.

July 22, February 3, June 19.

(r) GABOON VIPER, *Bitis gabonensis*.

July 24, December 6, May 17, July 23.

From the above records it may be observed that snakes may shed on as many as nine occasions in the course of a year, and as few as three occasions, the intervening periods varying from fourteen days to six and a half months. Quite young snakes shed about the second or third day after birth and again a fortnight later. A common ailment to which many captive specimens succumb is the inability to shed, and they should, therefore, be aided in the operation when necessary.

The food of most snakes consists of mammals, birds, lizards, frogs, and fish. Few snakes are, strictly speaking, cannibals, but a good many eat other snakes specifically different from themselves. Some are fond of eggs, while a few are insectivorous. Vegetarian snakes are unknown.

Snakes employ various methods for killing their prey. The Boas and Pythons, and various other non-poisonous kinds, having seized the victim, throw one or more of their coils round it, and crush it to death; they do not, as has often been stated, break the bones in order to reduce its bulk. Many non-poisonous species, and a few of the poisonous ones, start feeding straight away, without any attempt at killing, while other poisonous snakes, and most vipers, strike at their food before seizing it, and patiently wait for the poison to take effect. In most cases

the prey, whether constricted, eaten straight away, or poisoned, is killed rapidly and painlessly, and it is only the ignorant who bring charges of cruelty against those who offer their captive specimens living food. It is by no means a necessity, however, to give snakes live animals, for, with the exception of a few individuals which cannot be made to accept dead food, under any circumstances, they may all, poisonous as well as non-poisonous, be induced to accept freshly killed animals, these being constricted, struck at, or eaten straight away, as if they were alive. Whether the feeding of captive snakes on dead food is harmful to them or not is a debatable point, those against such a method of feeding being of the opinion that when the snake kills its prey, a certain excitement is produced which stimulates the gastric juices, a necessary condition for the proper digestion of the food. Some snakes will refuse all food, whether alive or dead, and, although capable of fasting for a considerable time, will gradually starve themselves to death, unless fed by force. Cramming, however, is not always successful, for snakes, being extremely nervous creatures, often suffer from the shock resulting from such methods, which merely accelerate their death.

A snake almost invariably starts its meal on the head end of its prey. The head having been found, it fixes its teeth into its food, pushing itself further and further forward, outside the animal, until the latter has been entirely engulfed. Snakes are often said to wet the carcass all over before commencing to feed, in order that the food may be more easily swallowed. I have never been able to verify this assertion, which probably originates from

the fact that, in order to locate the head, they will frequently pass their tongue all over the animal.

The power of fascinating other animals, so often attributed to snakes, is known to be a fallacy by all who have any experience of these creatures, for when live mice, rabbits, ducks, etc., are introduced into their cage, these will often immediately settle down on the coils of the snake, or force them, by biting or pecking, to quit some snug corner which they desire to appropriate. Some interesting observations have been made on the behaviour of different animals in the presence of snakes, by Dr. Chalmers Mitchell and Mr. R. I. Pocock. They found that, with the exception of monkeys, the majority of which, without doubt, recognized snakes, and were much alarmed, all animals were totally indifferent to their presence. Of the monkeys, it was noted that the lower ones were only mildly alarmed, while the lemurs had not the slightest fear, and would, had they been given the opportunity, have seized them and probably attempted to devour them.

The process of swallowing is a more or less mechanical one, and snakes, being provided with recurved teeth, once they have caught hold of their prey, are forced to go on swallowing until it has entirely disappeared. When several snakes are kept together in a small cage, two will often seize hold of the same prey at opposite ends, and consequently when their snouts meet, in the middle of the animal's body, the snake with the larger gape is forcibly compelled to swallow its companion. That the sense of taste is almost entirely absent in snakes was demonstrated some years ago in our reptile house, when a large Python swallowed its blanket, which fortunately was disgorged

some hours later, and by the following incident related by Mr. G. Abercromby. "I had flung a dead rat into the cage and was moving it about with a bamboo stick, which I afterwards placed near the snake's head. The latter saw something moving and smelt the rat, so it straightway seized hold of the bamboo rod, which it eventually proceeded to swallow. After it had got about two feet of the stick down its throat it discovered its mistake, and disgorged it." The snake in question was a half-grown Indian Python.

Although sometimes indifferent feeders, snakes always drink much, the water being drawn into the mouth, and not lapped up with the tongue, as in the case of most lizards.

Snakes frequently harmonize with their surroundings, many of the Tree Snakes, for instance, being green, while desert species are often light brown or pale yellow; some, however, are ornamented with the most conspicuous markings, which are sometimes considered to be "warning colours." The fact that some perfectly harmless snakes are often very similar in their markings to the poisonous species has been explained as the result of mimicry, these harmless creatures deriving benefit from their resemblance to the more dreaded kind. The coloration varies greatly individually, or according to the age of the animal, the newly born young being sometimes entirely different in their ornamentation, or even coloration, to their parents.

Some snakes lay eggs, which have a tough, parchment-like shell; others retain them within the body until the young are fully developed. The eggs, which are

usually oval or elliptical in shape, are produced singly, but, being besmeared with a viscous secretion, stick together, forming a clump. They are usually deposited in manure heaps or among dead leaves. In some cases the mother zealously guards the eggs by coiling herself round them and subjecting them to a sort of incubation, it having been ascertained that the temperature within the coils is higher than that of the surroundings. The number of eggs or young varies enormously according to the species, the lowest number being two, the highest about one hundred and ten.

As in the case of other reptiles, snakes hibernate in the temperate and sub-tropical parts of the world.

Although such a large number of mammals and birds are preyed upon by snakes, the latter have themselves many enemies, being in turn preyed upon by the Mongoose, Wild Pigs, Hedgehogs, the Secretary Bird, and various species of Storks. The frequently repeated statement that these creatures are absolutely immune to snake-bite is not to be taken without restriction. Dr. Calmette has conducted experiments in order to determine the limit of tolerance of the mongoose with respect to snake venom; he found that, although capable of withstanding doses which were considerable in proportion to the animal's size, and which would prove fatal to other animals, the mongoose was by no means absolutely immune, and that in most cases the little animal was victorious in its fights with poisonous snakes as a result of its extreme agility. He gives the following interesting account of a combat between a Mongoose and a large Hamadryad—

"The snake rose immediately, dilated its hood and struck savagely at the little animal, which, darting nimbly out of the way, escaped being seized, and, frightened for a moment, took refuge in a corner of the cage. Its stupor, however, was but of brief duration, for at the very moment when the Hamadryad was preparing to strike at it again, the Mongoose, with open mouth and snarling, sprang upon the reptile's head, bit it hard in the upper jaw, and crushed its skull in a few seconds."

Snakes have numerous external, as well as internal, parasites, and specimens freshly imported from the tropics are often entirely covered with blood-sucking ticks. The most efficacious manner of removing these is to wash the animal's body with paraffin, such treatment speedily exterminating the parasites. In captivity, at least, snakes are subject to various diseases. A highly infectious, and often fatal, one is a mouth disease, which in many respects resembles what is known as thrush in man. It starts with a small "canker" at the tip of the snout, which soon spreads to the mouth, causing sloughing of the infected parts, and which, unless arrested by washing with antiseptic solution, often spreads to the intestinal regions. In bad cases necrosis of the jaw sets in. Boas and Pythons, which are specially liable to mouth disease, I find are often speedily cured, if taken in hand in good time, by being kept immersed in water at a high temperature, and only taken out once a day for the purpose of cleansing the infected parts. The previously alluded to inability to shed their epidermis is another very common snake ailment.

The largest snake yet recorded, a specimen of the

Reticulated Python, is just under thirty-three feet in length, and the various accounts which have from time to time been given by travellers of encounters with snakes of over fifty feet long, are absolutely untrustworthy.

The age to which snakes live can only be judged by their rate of growth in captivity, the thirty-foot-long specimens being probably close on a century old.

The members of the two families *TYPHLOPIDÆ* and *GLAUCONIIDÆ* are small, worm-like creatures, with teeth

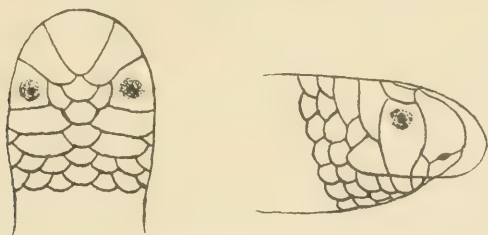


Fig. 7.—Head of *Glauconia blanfordii*.

in one of the jaws only, without enlarged ventral shields, with minute eyes, more or less hidden under the scales, and with a short, stump-like tail, which often terminates in a small spine. The body, the posterior portion of which is sometimes much thicker than the anterior, is covered with highly polished scales.

The distinction between the two families lies in the fact that whereas in the *Typhlopidae* the teeth are restricted to the upper jaw, in the *Glauconiidae* the reverse is the case, the lower jaw only being toothed.

These snakes are distributed over the greater part of the world, and are mostly of very small size, some measuring but six inches in length. They are all burrowers, and only

appear on the surface after heavy showers, when they search for the worms upon which they live. Their eggs, deposited in burrows several inches underground, are remarkable for their large size.

Although these worm-like creatures cannot be regarded as derived from any of the lizards with which we are acquainted, they show relation to them in being provided with rudiments of the hip-girdle, a character in which they agree with the following family—the *BOIDÆ*.

The Boa family, represented in all tropical countries, includes the largest snakes, and combines, with a much higher organization than the preceding, vestiges of hind limbs, which in many cases terminate in a claw-like spur, visible externally.

They are all constrictors, killing their prey by throwing their coils around them and crushing them to death, and consequently their bodies are usually thick in proportion to their length, owing to the presence of strongly developed muscles from which they develop their crushing power. The very largest of these snakes, which may measure thirty-five feet in length, although able to overpower very big animals, of the size of a bull, have not sufficiently wide a gape, even when fully expanded, to permit them to devour anything much larger than a goat or small antelope, and the accounts of their swallowing feats have often been much exaggerated.

The family is divided into two sub-families—the *Pythoninæ*, in which a bone above the eye, the *supra-orbital*, is present, and the *Boinæ*, in which it is absent, as in all other snakes. The allies of the Pythons may be, as a rule, further distinguished from those of the Boas by

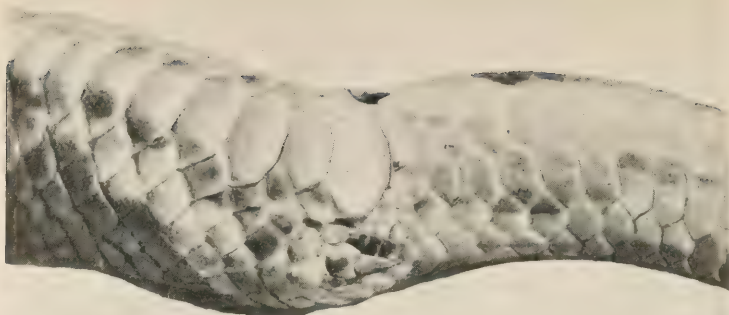


Head of Puff Adder, *Bitis arietans*, showing fangs.

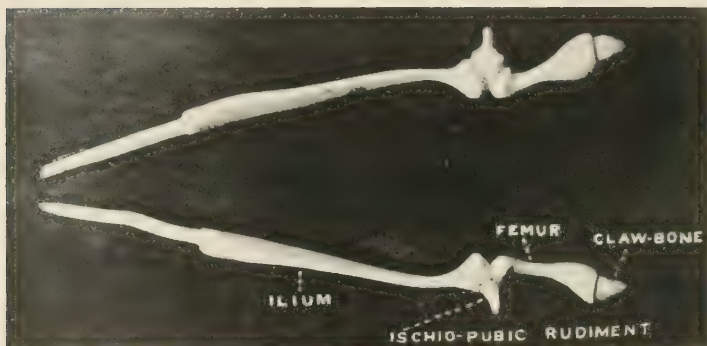


Cast "skin" of Puff Adder, *Bitis arietans*, showing the eye-scales.

(a)



(b)



(c)



(a) Part of Indian Python (*Python molurus*), showing rudimentary hind-limbs.

(b) Complete Bones of the Hinder Limb-girdle of Python.
(From Guide to the Reptile Gallery of the B.M.)

(c) West African Typhlops, *Typhlops punctatus*.

having large and irregular shields on the anterior half of the head, which, in the Boas, are mostly small or broken up into scales. The teeth are large and much recurved. The tail is, with a few exceptions, prehensile.

The large Boas and Pythons are often said to fast for a considerable period after a heavy meal. Mr. H. N. Ridley, writing of the Pythons in the Botanical Gardens at Singapore, states that the small-sized snakes feed usually once a month, while the larger ones, of about twenty feet, usually once in six to nine months. One which was twenty-two feet long, not long after it was brought to the gardens, passed the remains of a deer. It fed again some time later on three chickens, and abstained from food for six months, when it passed the remains of the fowls, and then ate a good-sized pariah dog, which lasted it for nine months. The experiences of Prof. Vaillant, of the Jardin des Plantes in Paris, do not quite coincide with those of Mr. Ridley, a twenty-one-foot long Anaconda, upon which he kept observation for six and a half years, feeding during this period on only thirty-four occasions, an average of five times a year. The table below shows how my experience

Name.	Length.	No. of times fed during the year.	Total Amount.
Reticulated Python, <i>Python reticulatus</i>	22 ft.	30	16 Kids, 17 Ducks.
" "	16 "	22	25 Ducks, 3 Pigeons, 3 Rabbits.
" "	14 "	32	31 Ducks, 8 Pigeons.
Indian Python, <i>Python molurus</i>	12 "	14	13 Pigeons, 9 Rabbits.
" "	9 "	10	7 Rabbits, 3 Pigeons.
Common Boa, <i>Boa constrictor</i>	9 "	35	23 Rabbits, 13 Pigeons, 2 Rats.
" "	8 "	14	11 Pigeons, 8 Rabbits, 3 Rats.
" "	4 "	17	33 Rats.

differs from that of Mr. Ridley and of Prof. Vaillant, the Boas and Pythons in the London Zoological Gardens, big and small, feeding on the average once a fortnight during the summer, and about once a month during the winter. As may be observed, a Python, twenty-two feet in length, fed on as many as thirty occasions in the course of a year, while an adult Boa fed on thirty-five occasions.

Unless disturbed, in confinement at least, these snakes are very lethargic, seldom moving during the daytime, when their elliptic pupils are so contracted as to be almost invisible; at night they become more active, and climb the trees in their cages with some activity.

All Pythons lay eggs, which are incubated by the mother, while the Boas, without exception, bring forth their young alive.

In the true Pythons, genus *Python*, restricted to the Old World, the head is elongate and flat; the nostrils are situated between two shields only, which are unequal in size; the shield capping the end of the snout and the shields on both lips are deeply pitted.

Pythons are found in the tropical parts of Africa, Asia, the East Indian Archipelago, and Australia. They are all expert both in swimming and climbing, and are generally to be found on the lower branches of trees in the neighbourhood of water.

Various species of Pythons have bred in captivity. The eggs, which number from fifty to one hundred, are in all cases protected, the mother coiling herself round them, supplying the necessary heat for their incubation. The following notes refer to the temperature during the incubation of the eggs of a pair of large African Pythons (*P. sebæ*), which bred in our gardens some years ago,



Reticulated Python, *Python reticulatus*.



Reticulated Python, constricting a kid.



Indian Python, *Python molurus*.

showing the increased temperature within the coils of the female during this period. Although these notes only refer to February and March, the eggs were incubated for over four months, when they decomposed and were removed.

Date.	Temp. of Cage.	Temp. of Male.	Temp. of Female.	Difference between temp. of Male and Female.
Feb. 23	65'4	On surface . . 71'8 Between coils . . 74'0	75'4 83'2	3'6 9'2
Mar. 2	60'0	On surface . . 71'6 Between coils . . 76'0	84'0 96'0	12'4 20'0
Mar. 16	66'0	On surface . . 72'4 Between coils . . 77'6	77'6 86'0	5'2 8'4

W. A. Forbes has also made observations on the incubation of Python eggs. The snake, a twelve-foot-long Indian Python (*P. molurus*), in this case guarded the eggs, half of which hatched, for a period of just over two months. The following table records his observations.

Date.	Temp. of Cage.	Temp. of Male.	Temp. of Female.	Difference between temp. of Male and Female.
June 18	75	On surface . . 83'2 Between coils . . 85'5	84'6 91'0	1'4 5'5
„ 22	77	On surface . . 79'0 Between coils . . 83'7	83'4 89'5	4'4 5'8
„ 24	75	On surface . . 79'5 Between coils . . 84'4	80'2 88'7	7 4'3
„ 29	75	On surface . . 77'6 Between coils . . 80'6	82'6 88'2	5'0 7'6
July 6	77	On surface . . 80'9 Between coils . . 84'7	82'7 88'1	1'8 3'4
„ 13	79	On surface . . 83'7 Between coils . . 85'5	86'2 89'3	2'5 3'8

The author remarks that the average difference is nearly identical with that which occurs in the case of the temperature of fever-patients, as compared with the normal. The increase of heat in an incubating bird is essentially of the same nature as that produced by an inflammation of tissue, and such is presumably the case in these reptiles.

The RETICULATED PYTHON, *P. reticulatus*, the largest of all snakes, attaining a length of over thirty feet, inhabits Indo-China and the Malay Peninsula and Archipelago. It is light yellowish-brown in colour, with large circular cross-shaped or diamond-shaped bluish-black markings, sometimes edged with white; a thin black line extends along the middle of the head from the end of the snout to the nape. An even more detailed account of its coloration would not do the snake justice, for in the sunlight the beauty of its iridescent tints is quite beyond description. It is a savage snake, and usually untamable, but does exceedingly well in captivity; although somewhat capricious in the choice of its food, most specimens feed with some regularity. As an example of its capricious appetite, I would relate the curious story told of a specimen which lived some years ago in the Menagerie of the Jardin des Plantes. The snake in question, a very large one, had been starving for some months, although it had been offered kids, rabbits, guinea-pigs, and various fowls, when a goose, which formed part of the collection and which had injured its leg, was put into the cage. The snake at once seized hold of it, and thus made its first meal since its arrival in Paris. It was naturally thought that, having lost its sulkiness, it would henceforth go on feeding. Not so, however; the ordinary bill of fare of captive Pythons was

persistently refused, until, as an experiment, a goose was again offered and immediately accepted. So it went on, the snake taking geese, but refusing all other food, such as served for the maintenance of other specimens of the same species.

According to the various observations made on the rate of growth of this Python, it increases in size very much quicker in the early periods of its life than afterwards, a ten-foot-long specimen being only about four years old, a twenty-foot-long specimen, twenty years old, while the thirty-foot-long giants must have reached, at the minimum, the three score and ten. An individual which measured eleven feet long on its arrival at the Zoological Gardens, grew in ten years to a length of twenty-one feet. Another grew in fourteen years from nineteen feet to twenty-four feet, showing how slow the rate of growth is in large specimens, and the great age which is undoubtedly attained by individuals of this species.

The INDIAN PYTHON, *P. molurus*, which is abundant over the whole of India and Ceylon, and is also occasionally found in the Malay Peninsula and Java, although not attaining quite as great a length as the Reticulated Python, is perhaps even more formidable, being a much heavier snake. Its ground colour is dark brown or yellowish, with elongate, irregular dark blotches. A large and broad dark patch occupies the crown of the head. The dark brown form is restricted to Northern India and the Malay countries, the yellow one to Southern India and Ceylon. The dark specimens are often said to be much fiercer than the light ones, but, as far as my experience goes, this is by no means the case, for of the few tame specimens that I have handled,

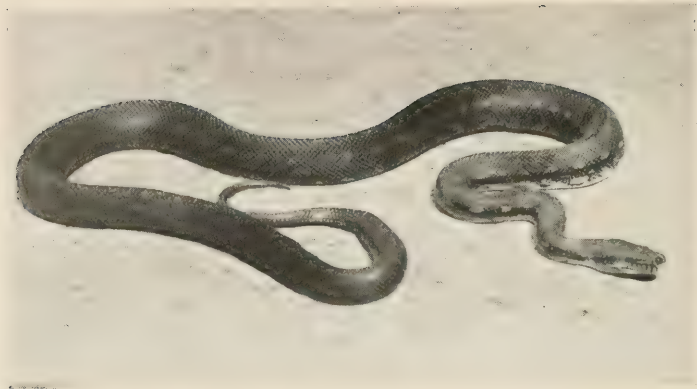
nearly all belonged to the former. The Indian Python is a hardy snake, feeding at a comparatively low temperature, and is consequently imported in fairly large numbers. Its eggs were successfully hatched in Hagenbeck's Menagerie, the period of incubation extending over two months; the young snakes, measuring as much as two feet in length, made use of their broken egg-shells as nests, returning to them when tired of crawling about, or when disturbed.

The COMMON AFRICAN PYTHON, *P. sebae*, ranging over the whole of tropical Africa, somewhat resembles *P. molurus* in coloration; the markings, however, take the form of wavy cross bands, connected by a dark band along each side of the body. This snake, which grows to a length of twenty feet, is very hardy, and is able to withstand very prolonged fasts, a specimen in the Jardin des Plantes refusing all food during its captivity, a period of nearly three years. It is hunted for in many parts of Africa, where grilled python is considered a delicacy. The colonists misname it "Boa constrictor."

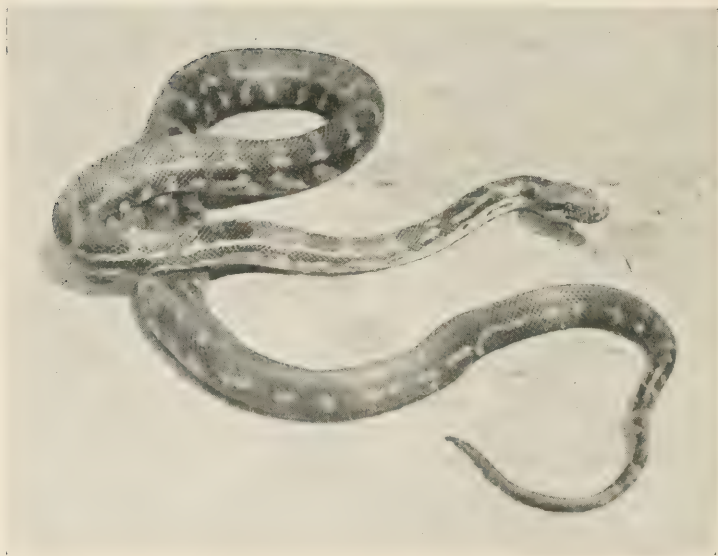
The ROYAL PYTHON, *P. regius*, is a small form, seldom exceeding six feet in length, restricted to the Western and Eastern Sudan. The upper surface of the head is dark brown, with a very pale black-edged streak along each side, which passes through the eye; a dark brown, black-edged band, enclosing numerous round or oval light spots, occupies the back, sending down triangular markings on the sides, which are much paler. Unlike other members of the genus this python is, as a rule, very good tempered, freshly captured specimens, when handled, making no attempt to bite, merely hiding their heads under the coils.



Royal Python, *Python regius*.



Diamond Python, *Python spilotes*.



Carpet Python, *Python spilotes*, var. *variegata*.

The MALAY PYTHON, *P. curtus*, of the Malay Peninsula, Sumatra, and Borneo, is a short but very stout snake, growing to a length of nine feet. It is brick-red above, with a dorsal series of round pale spots, which are often confluent into a stripe on the posterior part of the back. This snake, which is said to feed chiefly on rats, frequents swampy country, and is known to the natives as "the Blood Python."

The DIAMOND PYTHON, *P. spilotes*, of New South Wales, the largest snake inhabiting Australia, reaching a length of eight feet, is frequently imported to Europe. The general colour is bluish-black, while every scale of the body is marked with a yellow spot in the centre, and often with a somewhat indistinct yellow streak on each side.

A variety of this snake, var. *variegata*, popularly known as the CARPET PYTHON, does not differ in general structure or scaling, but only in coloration. Its ground colour, which is greenish-brown, is marked out into several rows of irregular lozenge-shaped patches of yellow. Its range is much wider than the typical form, being found in Victoria and Southern and Western Australia, as well as in New South Wales.

In their habits both the Diamond Python and the Carpet Python are precisely similar. They frequent open, stony ridges, well supplied with water, or the banks of swamps and lagoons, where they find an ample supply of small mammals and young water-fowl. The Australian Pythons are, unfortunately, not hardy, seldom surviving more than a couple of years of captivity.

In the West African genus *Calabaria*, which is represented by a single species, *C. reinhardti*, the head, which is

covered with moderately large scales, is not distinct from the neck, while the non-prehensile tail is short and rounded at the end, resembling in shape the animal's small head.

The creature spends the greater part of its existence underground, entering the burrows of the small rodents upon which it feeds. A specimen kept by the writer usually remained below ground, appearing on the surface only towards dusk. When brought above ground and released, it burrowed down again so rapidly that the entire body was out of sight in a few seconds. It fed fairly regularly on mice, these being taken invariably at night. The general colour of the snake is purplish-brown, with more or less numerous, irregularly scattered, yellowish spots. It attains a maximum length of three feet.

The majority of the members of the sub-family *Boinæ* inhabit Central and South America and the West Indies. A few genera are found in South-Eastern Europe, South-Western Asia, North Africa, in New Guinea, in some of the islands of the South Pacific and in Mauritius: the otherwise American genera, *Boa* and *Corallus*, are each represented by one species in Madagascar.

The ANACONDA, *Eunectes murinus*, the largest of the American snakes, almost equalling the Reticulated Python in length, inhabits the Guianas, Brazil, and Peru. The head is elongate, flat, and very distinct from the neck, while the snout is covered with moderately large scales. The nostrils, which are directed upwards, are situated between three large shields. The pattern of this snake is leopard-like, being greenish-yellow above, with a single series, or with two alternating series, of large, blackish, transverse spots, and one or two lateral series of blackish

eye-spots with white centres. The top of the head is very dark, and separated from the paler sides by a black streak forming a point on the snout ; an oblique streak is situated on each side behind the eye. The lower parts are whitish, spotted with black. The Anaconda is very aquatic, and is usually found submerged close to the banks of the river, on the look-out for its prey. Although mammals and crocodiles are occasionally eaten by this snake, it usually prefers birds, these being constricted and eaten under water. In spite of the fact that only a single instance of an Anaconda having attacked man is on record, there is a very great dread of this giant snake among the natives. Although it grows to a length of over thirty feet, it is sexually mature when about half that length, a sixteen-foot-long specimen in our gardens having quite recently given birth to four young, while Ditmars mentions a specimen in the New York Gardens, of only a foot longer, which brought forth a brood of as many as thirty-four.

The four young mentioned above measured thirty-five to thirty-six inches in length, and weighed fourteen to sixteen ounces. The pattern of the newly born snakes was identical with that of their parent.

A smaller species of Anaconda, *E. notæus*, inhabits the Argentine Republic and Paraguay.

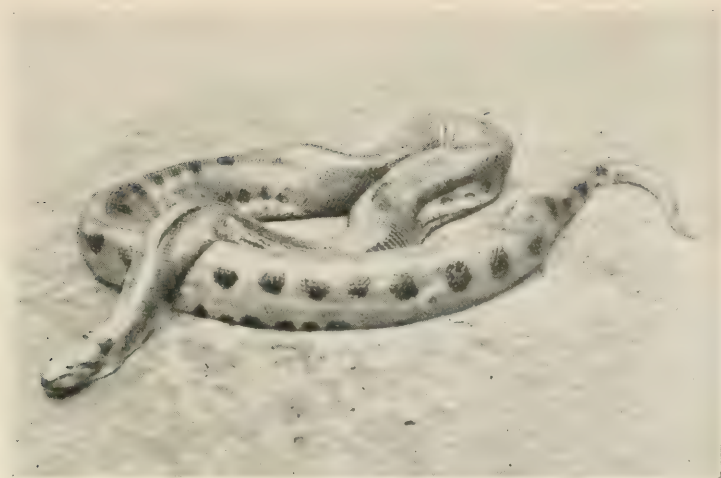
The Boas proper, genus *Boa*, number seven species, inhabiting Tropical America and Madagascar. The fact that this and a few other typical South American genera are represented in Madagascar has suggested the inadmissible theory that, at some time or other, the island was connected with South America, a connection from which Africa was excluded. In this genus the body, the scales on which are smooth, is feebly compressed. The

scales of the head are small and broken up. The nostril is situated between three shields, which are separated from those of the other side by minute scales.

The COMMON BOA, *Boa constrictor*, of the West Indies and the greater part of Tropical America, has a larger number of scales round the body than the other species, these numbering up to ninety-five. The colour varies considerably; it may be pale or dark brown, grey, or pinkish above, with about fifteen dark brown or black cross-bars, widening on each side, where they are usually connected by a dark streak, which encloses large oval spots of the pale ground colour. On the tail the markings become much larger, and are reddish-brown or even brick-red, edged with black, and separated by narrow yellow interspaces.

The Boa Constrictor is popularly supposed to be the giant among snakes, although in reality it seldom attains a length of more than twelve feet, and in size, therefore, cannot be compared with the Anaconda, or several of the Pythons.

Fond of taking an occasional bath, Boas never remain for long in the water, and do not, as in the case of Pythons, wait by the water's edge to secure their prey, preferring to rest fairly high up in the branches of trees. The Common Boa, although frequently very savage when freshly captured, becomes quite tame after only a few weeks of captivity. The snake is a good feeder, one of the specimens under my charge, as previously alluded to, having fed on as many as thirty-five occasions in the course of a year, devouring in all twenty-three rabbits, thirteen pigeons, and three rats.



Anaconda, *Eunectes murinus*.



Common Boa, *Boa constrictor*.



Rainbow Boa, *Epicrates cenchris*.



Madagascar Tree Boa, *Corallus madagascariensis*.

Boas do not feed on other snakes, but when several specimens are kept together in the same cage, two are liable to seize upon their prey at opposite ends, with the result that the smaller specimen is swallowed by the larger. The following extract of an account of such an occurrence has been given by A. D. Bartlett in the *Proceedings of the Zoological Society*.

“ Since January last two fine examples of the Common Boa (eleven feet and nine feet in length) have lived together on friendly terms in one of the large compartments in the Reptile House.

“ The snakes are usually fed at dusk once a week, and, on the evening of October 5, Tyrrell, the keeper of the Reptile House, placed two pigeons in the den of the two Boa Constrictors. The larger one seized one of the pigeons, and no doubt swallowed it, after which the keeper closed the house and left. On his return next morning he was astonished to find only one Boa in the compartment instead of two, and, from the enormously increased size of the remaining one, he concluded at once that the larger Boa had swallowed its companion. That this was so was evident to all who visited the house.

“ The enormous enlargement of the creature's body was remarkable. It had no longer the power of curling itself round, as snakes usually do, but remained extended nearly its full length in a straight line, and appeared to be at least three times its normal size in circumference. It was almost painful to see the distended skin, which had separated the scales all over the middle of the body. After examining the snake, my expectation was that it would ultimately disgorge its companion. Recalling to mind a

former and very similar case, in which the decomposing body of the snake swallowed caused the death of its destroyer, I had much doubt about the digestive powers of this animal. But in the present instance the snake not only digested its companion, but regained its appetite as well as its normal size. On November 2, the keeper, finding the creature moving about as if in search of food, placed a pigeon in its den, which was seized and swallowed immediately. It will be seen by this that a serpent of eleven feet in length can not only swallow and digest another serpent only about two feet shorter, but is ready to feed again twenty-eight days afterwards."

In *Epicrates*, a South American genus composed of six species, the head is distinct from the neck, and covered with moderately large shields. The body is rather slender and somewhat compressed; the nostrils are situated between two or three shields.

The RAINBOW BOA, *Epicrates cenchris*, of Tropical America, from Costa Rica to Northern Brazil, which attains seven feet in length, is so called on account of its marvellous iridescence, when exposed to sunlight. On a dull day it is very insignificant looking, being pale brown in colour, with rings of a slightly darker shade.

Although frequently termed "Tree Boa," according to Mr. R. R. Mole, it does not often ascend trees, but is usually found in holes in the ground, or on palm-thatched roofs. According to the same author, it is so exceedingly fond of water that, in order to enjoy a bath, it will contrive to get into a bottle of water in which it would be almost impossible to put a dead specimen.

The true Tree Boas of the genus *Corallus*, also of

Tropical America and of Madagascar, may be at once recognized by their extremely slender necks, their large heads, and their prominent eyes. The body is elongate and compressed; the lips are deeply pitted. All the snakes of this genus, of which there are six species, are very savage, attacking without any provocation. The young, produced in broods of twenty or thirty at a time, are remarkable for the enormous size of their heads.

COOK'S TREE BOA, *Corallus cookii*, of which there are numerous local varieties, is the commonest species, its range extending over the greater part of Tropical America and the West Indies. It is a dull yellow or olive brown in colour, variegated with dark lines or ocellar spots. As in the case of the Rainbow Boa, it presents a remarkably handsome appearance in the sunlight, when its dull coloration changes to bluish or purplish iridescent tints.

Corallus caninus, of Brazil and Peru, is bright green, harmonizing with the foliage of the trees upon which it lives.

The snakes of the burrowing genus *Eryx* take the place among the *Boinæ*, of the genus *Calabaria*, of the *Pythoninæ*. There are seven species in all, inhabiting the dry, sandy plains of South-east Europe, North and East Africa, and Southern and Central Asia. The head is not distinct from the neck, and is covered, but for a large shield on the tip of the snout, with minute scales. The body is cylindrical, the eye minute. The tail is quite short, stump-like or conical.

The INDIAN ERYX, *E. jobnii*, which is sandy brown in colour, has a remarkably short and rounded tail. It is

often known as the Two-headed Snake, and is hawked about by the Indian snake charmers, who mutilate or modify the tail end, so as to make it resemble the head, these men declaring not only that each end feeds in turn, but that while the one end sleeps the other watches.

Mr. C. R. Walter recently sent me some newly born specimens, from a brood of nine, born in his Reptile House. These were quite unlike their parents, being of a uniform flesh-colour. A few months after birth the colour changed, becoming pale coral red, and finally assuming the sandy brown of the adult.

The JAVELIN ERYX, *E. jaculus*, of South-Western and Central Asia and North Africa, is particularly abundant in Lower Egypt. This snake, which is similar in shape to *E. johnii*, is greyish or reddish above, with dark brown or blackish transverse blotches or alternating spots. A deception by the Egyptian snake charmers is also practised with this species, the snake's head being pierced, above each eye, with hedgehog spines, and thus made to resemble the venomous and much dreaded Horned Viper (*Cerastes cornutus*).

The family COLUBRIDÆ, which comprises the greater number of living snakes, and forms the great bulk of the order, is divided up into about 250 genera. The species show almost every possible form and structure, as their habits are as various as we can imagine. The majority are typical ground snakes; others, however, are burrowing, arboreal, or aquatic. They are represented all over the temperate and tropical regions, with the exception of Ireland, New Zealand, and some of the islands of the Pacific. The family is divided into three divisions—



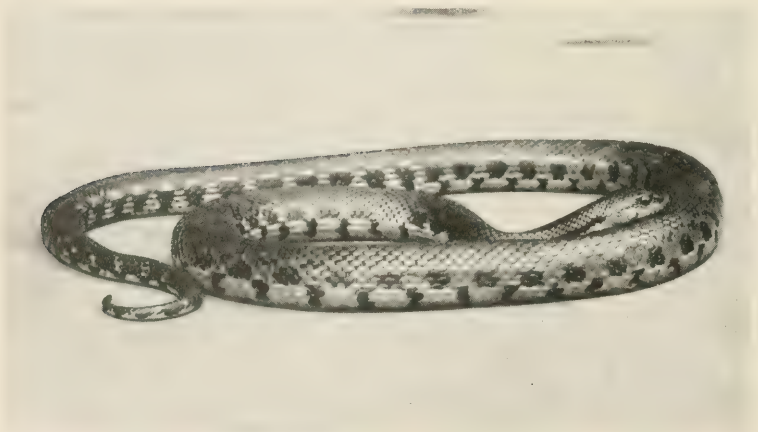
Indian Eryx, *Eryx johnii*.



African Burrowing Boa, *Calabaria reinhardtii*.



Elephant-trunk Snake, *Acrochordus javanicus*.



Sharp-nosed Snake, *Liobheterodon madagascariensis*.

(a) The *Aglypha*, harmless snakes, which have all the teeth solid, not grooved.

(b) The *Opisthoglypha*, which are more or less poisonous, having the posterior maxillary teeth grooved.

(c) The *Proteroglypha*, which are all highly poisonous, having the anterior maxillary teeth grooved or canaliculated.

The AGLYPHA are divided up into the following three sub-families.

1. The *Acrochordinæ*.—Aquatic snakes, which are distinguished by their juxtaposed, or small wart-like tubercular scales.

2. The *Colubrinæ*.—The typical harmless snakes.

3. The *Rhachiodontinæ*.—Egg-eating snakes with rudimentary teeth.

The members of the sub-family *Acrochordinæ* live in fresh or brackish water, some species occasionally swimming out to sea.

The scales of the body are juxtaposed, not overlapping, as in the typical snakes, while the nostrils are situated on the top of the head.

Acrochordus javanicus, the ELEPHANT TRUNK SNAKE, as this very ugly snake is called in the Malay Peninsula, on account of the superficial resemblance of its thick grey body to an elephant's proboscis, inhabits the ditches and canals of Siam and the Malay Peninsula and Archipelago. The head, which is not at all distinct from the neck, is covered, like the whole body, with small, rough scales, resembling the shagreen of sharks. The scales, which are all alike, there being no enlarged ventral shields, number up to 150 round the body.

This species feeds probably exclusively on fish, as my captive specimens refused frogs and all other food; these snakes were at all times very ill-tempered, literally throwing themselves, when out of the water, at the intruder. They shed at intervals of about three months, the "skin" coming off, unlike many other purely aquatic snakes, entire. Cantor, who has compared its physiognomy to that of a bulldog, observed a female in his possession to bring forth twenty-seven young ones. In Siam the Elephant Trunk Snake is highly valued for its skin, which is used by the natives for making drum-heads.

In dealing with the sub-family *Colubrinæ* we shall begin with the genus *Tropidonotus*, of which the Grass Snake is the well-known British representative. The head is distinct from the neck; the eye, which varies much in size, according to the species, is provided with a round pupil. The cylindrical body is rather elongate; the scales are mostly keeled. In the upper jaw the posterior teeth are the longest, while in the lower jaw they are all sub-equal in size.

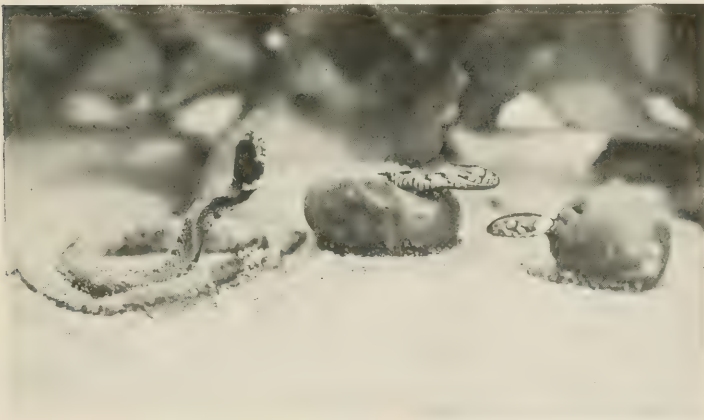
Tropidonotus is distributed over Europe, Asia, Africa, North Australia, and North and Central America.

All the Old World species, so far as we know, lay eggs, while, without exception, those of the New World bring forth their young alive.

The COMMON GRASS SNAKE, *T. natrix*, of Europe, Algeria, West and Central Asia, is very abundant in many parts of the South of England; it is rare in the North of England, while in Scotland it is, as in Ireland, entirely absent. In form it is moderately slender, with a blunt and not very prominent snout. The scales round the



Common Grass Snake, *Tropidonotus natrix*.



Grass Snakes emerging from their eggs.



The False Mocassin, *Tropidonotus fasciatus*, var. *rhombifer*.



Garter Snake, *Tropidonotus ordinatus*.

body invariably number nineteen. In coloration the Grass Snake is very variable; the typical form of England and Central Europe is grey, olive, or brown above, with black spots or narrow cross-bands; a white, yellow, or orange, sometimes interrupted, collar is situated on the nape, and is bordered behind by two black triangular or crescentic patches; the under-surfaces are checkered black-and-white, or grey. In Jersey and the Spanish Peninsula the collar-marking, which is invariably present in the quite young, is very much reduced, or even entirely absent in the adult. In Italy, South-Eastern Europe, and Asia Minor, another variety occurs, in which the collar, although well-defined, is widely interrupted in the middle, while a yellow or orange stripe extends along each side of the back. Specimens from Corsica and Sardinia are grey or olive above, with the black markings confluent into more or less regular annuli; the collar is absent, being transformed into the first annulus.

Although often found in the neighbourhood of water, the Grass Snake is not nearly so aquatic as most other members of its genus, being sometimes met with at great distances from water, and captive specimens do not thrive if kept in very humid surroundings, developing sores and refusing to feed. When freshly caught it hisses loudly without biting, but emits a very powerful and disagreeable odour from its anal glands, upon which it relies as a means of defence. The food of adult specimens consists of frogs, toads, and fishes; that of the young of earthworms and the larvæ or young of various Batrachians.

The Grass Snake pairs during the months of April and May, the eggs, ten to forty-five in number, which are

produced in a string and stick to one another, forming an irregular bunch, hatching a couple of months later. As the eggs are deposited under a mass of decomposing leaves, or in manure heaps, those laid in captivity should be placed under similar surroundings and kept at a high temperature. It is by no means easy to hatch the eggs under artificial conditions, for, unless kept moderately damp and at a uniform temperature of about 90°, they soon shrivel up and die. At birth the young snakes, measuring only about eight inches in length, are remarkably beautiful creatures, their light collar and their dark markings being very sharply defined. The snout of the newly born animals terminates, as in most snakes, in a minute, flat "egg tooth," which is shed on the second day after birth. My very young specimens were fed chiefly on the young of the common frog, each snake consuming three or four of these a week; fish, of which the adults are fond, were not accepted, which may be explained by the fact that the young, in all probability, never enter water. The Grass Snake hibernates during the winter months in holes in walls, or in manure heaps, not emerging again, in this country, until the beginning of April.

Although this snake does not often reach a length of four feet in the British Isles, giants measuring over six feet in length are known from Southern Europe. I have seen such specimens from Sardinia in the Florence Museum, the body being quite five inches in circumference.

The TESSELLATED SNAKE, *T. tessellatus*, has also a wide distribution in Central and Southern Europe, and in South-Western Asia. It may be easily distinguished from the Grass Snake by a narrower head, and by the eyes and

the nostrils being situated more on the upper portion of the head, in accordance with its very aquatic habits. Its usual coloration is olive grey, checkered with dark spots; a more or less distinct Λ -shaped dark band is situated on the back of the head and neck; the lower parts are yellow or red, spotted or marbled with black, or nearly entirely black.

The Tessellated Snake is usually found in the water, feeding principally on fish, which are taken on land to be devoured. It enters salt water, having been observed on the sea-shore hunting for small fish in the rock pools. Pairing takes place in the spring, the eggs, which seldom exceed twenty in number, being laid in a similar manner to those of the Grass Snake, hatching from eight to ten weeks later.

The VIPERINE SNAKE, *T. viperinus*, which is closely allied to the preceding species, but from which it differs in being of a less slender form, and in having twenty-one instead of nineteen scales round the body, is so called from its superficial resemblance to the Common Viper. It is brown or reddish above, with usually a black, zigzag dorsal band, often strikingly suggestive of that of the Viper, and a lateral series of black eye-spots with yellow centres.

In spite of its unprepossessing appearance, it seldom bites, and, as it is very hardy, makes an attractive pet. It is quite as aquatic as the Tessellated Snake, and is seldom found at any distance from the water. Besides feeding on fish and frogs, it will also accept earthworms. Although this snake pairs in the autumn as well as in the spring, the eggs are only laid in June and July, numbering up to twenty; they are deposited in holes in the neighbour-

hood of water, the abandoned galleries of moles being frequently appropriated for the purpose.

The INDIAN RIVER SNAKE, *T. piscator*, is the commonest snake of the East, being found in almost every pool and stream in India, Burma, Southern China, and the Malay Peninsula and Archipelago. When freshly captured it is very fierce; sitting up, it raises its head a foot or so from the ground, and inflates and laterally expands the skin of the neck, as do the cobras. In colour it is yellow or very pale olive above, with numerous black blotches or stripes; two oblique streaks are situated, one below and one above the eye. The lower parts, in specimens from India and Burma, are uniform yellowish, while, in those from Southern China and the Malay, the ventral shields are edged with black.

The Indian River Snake, attaining a length of just over four feet, is very aquatic, seldom leaving the water. In captivity it will live for long periods, feeding greedily on fish and frogs, five specimens in the Zoological Gardens having during the past year devoured in all over 800 of the latter.

The INDIAN STRIPED SNAKE, *T. stolatus*, a small species, which abounds all over India and Ceylon, and extends from Burma and China to the Malay Peninsula, is grey or brown above, with dark cross-bars, which are intersected by two yellow longitudinal bands.

The habits of this snake much resemble those of our Grass Snake, for, like the latter, it is not so fond of water as most other species of the genus; it is also a very gentle creature, seldom attempting to bite. The eggs, which number about a dozen to a clutch, and are frequently

laid in captivity, are very difficult to hatch under artificial conditions. Major Wall recommends as the best method to place them daily in fresh earth under an inverted flower-pot, the latter giving the necessary darkness. In the wild state the mother remains with the eggs until they are hatched.

The GARTER SNAKE, *T. ordinatus*, is found all over North and Central America, and is imported to this country in enormous quantities, being invariably on the market. This snake, the coloration of which is very variable, has been divided up into numerous species, which, owing to the existence of intermediate forms and the inconstancy of their characters, can hardly be regarded as more than geographical varieties. Although the typical form, which occurs in the United States, east of the Mississippi, is not provided with lateral or vertebral stripes, these are present in most forms, hence the name Garter Snake.

The typical form is olive or green above, uniform or with black spots. The variety *sirtalis*, of North America, east of the Rocky Mountains, and of North Mexico, is brownish-olive or black above, with three yellow, red, or pale green stripes. Another form is the variety *eques*, inhabiting Lower California, Texas, Arizona, Mexico, and Guatemala. It is olive above, with black spots, and a wide, deep orange vertebral stripe, and a yellow or white lateral band; a black collar is constant. In all the above-mentioned forms the scales are disposed in nineteen rows. In the variety *mocrostemma*, however, which also inhabits Mexico and Arizona, and which is olive brown, with dark spots, the scales are in twenty-one rows.

Garter Snakes frequent swamps or meadows where the

grass is long, feeding principally on fish, frogs, and toads; some individuals are insectivorous as well. Mr. J. L. Wortman has related how one day, in Canada, he was fishing and caught a number of chub, and, throwing them on the sand behind him, was surprised to see, some minutes later, when he turned round, that only a few remained. While quietly continuing to replace those so singularly missing he observed, behind him, a very large Garter Snake seize and swallow one of the fish six inches long. He killed the snake, and, upon opening it, found that it contained as many as six fishes.

Like all the American members of its genus, the Garter Snake is viviparous, bringing forth, late in the summer, a remarkably large number of young, usually about fifty to a brood; over seventy, however, is not exceptional, while broods of eighty have been recorded on more than one occasion.

The BANDED SNAKE, *T. fasciatus*, sometimes called Moccasin Snake, a name, however, which belongs to the viper *Ancistrodon piscivorus*, with which it is often confounded, is the American representative of *T. piscator*, like it spending most of its life in the water, preying upon frogs and fish. The coloration is usually dark brown, with irregular oblong or triangular reddish spots on the flanks. In old animals these spots become obsolete, the whole surface becoming of a brownish colour. The scales are in twenty-three or twenty-five rows. As in the case of the Garter Snake, numerous geographical varieties exist, of which the variety *rhombifer*, of New Orleans and Mexico, and the variety *sepedon*, of Pennsylvania, are the most distinct. In the former the coloration is pale brown,

with alternating series of dark brown spots, connected by dark meshes, and the scales are in twenty-five or twenty-seven rows; in the latter, in which the scales are disposed in twenty-three rows, the ground colour is darker and the spots are not connected up, the interspaces appearing as narrow light bands, margined with black.

A four-foot-long specimen of the first mentioned variety recently brought forth a brood of twenty-two young in our gardens. The newly born snakes, measuring eleven inches long at birth, were exceedingly fierce, and struck out right and left; they fed with avidity, accounting, in their first six months, when the majority had almost doubled in length, for over five hundred small frogs.

Liobheterodon, a genus represented by two species in Madagascar, differs from *Tropidonotus* in the shape of the head, which is scarcely distinct from the neck; the snout is pointed and projecting, much as in the North American *Heterodon*; the scales are smooth. The last two teeth of the upper jaw are very large and fang-like, and separated from the rest by an interspace.

The commoner species is *L. madagascariensis*, a robust snake, averaging six feet in length. The upper parts are elegantly ornamented with irregular brown and yellow spots, while the sides are yellow with alternating series of brown blotches. The snake, which is very hardy and of gentle disposition, is a voracious feeder, being equally fond of mammals, frogs, and eggs; the latter are surrounded by its coils before being devoured, and the shell is broken in the stomach and passed with the excrements.

The genus *Lycodon*, in which the body is long and slender, the head indistinct from the neck, and the small

eye provided with a vertically elliptical pupil, is remarkable for many of its members resembling, in a most striking manner, not only externally, but also in their large and recurved fang-like teeth, the very poisonous snakes of the Indian genus *Bungarus*; they may, however, be distinguished by the presence of a shield separating the nasal from the eye (the *loreal*), this shield being absent in all venomous Indian species of the Colubrine tribe.

In disposition these snakes vary considerably, some being bold and ferocious, whilst others will not bite, however much they are provoked.

The INDIAN WOLF SNAKE, *Lycodon aulicus*, which is constantly being confounded with the much dreaded Krait, *Bungarus cæruleus*, and which it superficially resembles both in form and coloration, inhabits India, Ceylon, Burma, and the Malay Peninsula and Archipelago. It is dark brown in colour, with whitish markings, which are, as in the case of the Common Krait, generally disposed in cross bands. The Wolf Snake is peculiar in being particularly abundant in the neighbourhood of dwellings, and frequently makes its home in the holes in the loose brickwork of buildings, in which it remains during the daytime. According to Major Wall, not only does it frequent houses such as are occupied by Europeans, but it often obtrudes itself into such densely populated parts as the bazaars, or the business quarters of many of the large Indian cities. Although usually very sluggish during the daytime, captive specimens, when provoked, become most active, and will attack with much courage. Being more or less nocturnal in the wild state, Geckos constitute their principal article of food. Wall Lizards make a good substitute in the case

of captive specimens. The eggs of the Wolf Snake, which vary in number from two to about a dozen, are frequently deposited in dwellings.

Pseudaspis, represented by a single species, restricted to South Africa, has the head but feebly distinct from the neck, while the snout is somewhat pointed, but much less so than in *Liobheterodon*. The body is stout and cylindrical, with very small scales (twenty-seven to thirty-one rows) all smooth. In the upper jaw the posterior teeth are longer than those in front, while in the lower the reverse is the case.

The MOLE SNAKE, *Pseudaspis cana*, which reaches a total length of six feet, is pale or dark brown or black in colour. The black specimens were formerly believed to constitute a distinct species or race, and named *P. phocarum*, after Robben Island ("Robben," Dutch for seals), near the Cape, where they are particularly abundant; it has now, however, been proved that the differences in colour are not connected with geographical localities, and that the black specimens produce young which are light brown in colour, with darker, white-edged spots forming longitudinal series, similar to those of the pale specimens.

Although living well in captivity, the Mole Snake is of a bold and vicious disposition, which it rarely shakes off. The habit of raising the fore part of its head and body in a cobra-like fashion before preparing to strike, which has been attributed to this reptile, has not been observed in the three specimens kept by the writer.

The Mole Snake is one of the most prolific of all snakes, producing over eighty living young at a time.

Zamenis, a terrestrial and often semi-arboreal genus,

represented in Europe, Asia, North Africa, and North and Central America, comprises about forty species. The head is elongate and distinct from the neck; the eye is large, with a round pupil; the body and tail, the scales of which are smooth or very feebly keeled, are long and cylindrical.

As their Greek name implies, these snakes are usually of fierce disposition; they feed principally on birds, mammals, and lizards, these never being constricted, but eaten straight away.

The INDIAN RAT SNAKE, *Zamenis mucosus*, the largest species of the genus, attaining nine feet in length, is abundant in India and Ceylon, where it is often met with in outhouses or even bungalows. In coloration it is lightish brown above, each scale being edged with black, the dark edges of the scales becoming broader on the posterior part of the body. The scales, which are disposed in nineteen rows on the back, are feebly keeled, the keels in some specimens being so faint as to appear entirely absent. The Rat Snake, which is remarkable for its agility, seeming, when pursued, almost to fly over the ground, is perhaps the most ill-tempered of all snakes, large specimens scarcely ever becoming tame, and frequently, in the case of captive specimens, injuring themselves by incessantly striking at the glass of their cage. When angry they have been said to flatten out their necks in a cobra-like fashion; but, although I have often seen them sit up in a vertical attitude, superficially resembling, when in such a position, the justly dreaded Hamadryad, I have never observed any dilation of the neck. When excited, at feeding times, for instance, a specimen now living in our gardens will produce the most peculiar musical sounds, such as has been observed

by Cantor, who, with some justification, compares the notes to those produced by a gently struck tuning-fork. The food of the Rat Snake does not, as its name suggests, consist entirely of rats, for it is partial to birds and frogs, while specimens have been caught in the act of devouring lizards and the soft-shelled turtles of the genus *Trionyx*.

The legends connected with this snake are many. In some parts of India, where it is held in some respect, being, in fact, believed to mate with the cobra, it is said, in spite of its long, pointed teeth, to suck the udders of cows. In Ceylon, however, it is considered a very low caste snake, the Singalese believing that once a man has been bitten by it, no other snake will bite him.

The eggs of the Rat Snake, which number from ten to about twenty to a clutch, are laid in holes in earth; the young on emerging immediately shift for themselves, and are as bold and ill-tempered as their parents.

The DARK GREEN SNAKE, *Zamenis gemonensis*, one of the commonest and largest of European snakes, attaining a length of over seven feet, is often known as the Angry Snake, in reference to its particularly savage temper, and the individuals in the Zoological Gardens seldom become at all tame, but continue to strike at the glass of their cages, sometimes for months after their arrival. The upper parts may vary in colour from pale olive to dark greenish brown or black, with yellow spots or longitudinal streaks, which frequently form transverse series on the anterior parts of the body, and regular longitudinal streaks on the tail; the lower parts are yellow or greenish-white, sometimes uniform, sometimes with dark spots, uniform orange or red in the variety *caspius*.

The Dark Green Snake, which ranges throughout Central and Eastern Europe, and is also found in South-Western Asia, lives in hedges or in woods, invariably avoiding damp localities. Although in the wild state it can no doubt withstand a considerable degree of cold, being found in the Alps at an altitude of nearly 4,000 feet, in captivity it on the contrary requires for its welfare a higher temperature than any other European snake. Its food varies considerably, consisting of small mammals, birds, lizards, other snakes, frogs and, according to Schreiber, even large grasshoppers.

Although so commonly kept in confinement, I cannot recall a single instance of its having deposited its eggs under these conditions.

The HORSE-SHOE SNAKE, *Zamenis hippocrepis*, the total length of which may attain five feet, is a Spanish, Portuguese, and North African species of, if possible, still fiercer disposition than the Dark Green Snake. It is slower in its movements than other members of the genus, and is, therefore, much more manageable. Although usually choosing the underground galleries of small mammals as its home, it frequently enters the dwellings of man. The eggs, only about four or five in number, are deposited during the months of July, August, and September.

The Horse-shoe Snake is most strikingly marked, its yellow or reddish ground colour being relieved with dark brown, black-edged, rhomboidal spots, on each side of which is a series of smaller alternating spots; these spots, which are occasionally entirely black, often reduce the ground colour to a mere chain or series of X's of yellow colour; a dark cross-band is present between the eyes,

and a horse-shoe shaped band, from which the snake receives its popular name, is situated on the nape; the under-surfaces are yellowish or red, with or without black spots.

DAHL'S SNAKE, *Zamenis dahlia*, a very slender snake, which seldom exceeds three feet in length, occurs in Europe east of the Adriatic; it also inhabits Asia Minor, North-Western Persia, and Syria. It is olive in colour, with a few large black, white or yellow-edged spots on the sides, the anterior pair of which are sometimes confluent and thus form a nuchal collar. Dahl's Snake is an exceedingly delicate creature, and cannot be kept under captive conditions for more than a few months, refusing to feed on the small lizards which, in its natural environment, constitute its principal article of food. It inhabits very dry localities, its dislike for water, in fact, being so great that it will not drink out of a bowl, but quenches its thirst by licking the dew-drops from the branches. According to Werner, the eggs number three only.

The DIADEM SNAKE, *Zamenis diadema*, which is frequently seen in menageries and is often in the possession of the Indian and Egyptian snake charmers, ranges from North Africa to North-Western India. It is normally pale buff or sometimes flesh-coloured above, with brown or reddish blotches, of which the median ones form, as a rule, a series of rhombs; the lower parts are uniform white. The variety *atriceps*, of Northern India, is peculiar in having the head entirely black and the body irregularly spotted with black. This beautiful snake is unfortunately rather delicate, and does not stand a long period of captivity, which is all the more to be

regretted, inasmuch as it is the only member of the genus which is of a gentle disposition. In America the snakes of the genus *Zamenis* are known as Racers or Whip Snakes, on account of the rapidity of their motions and the defensive use they make of their tails when cornered. The BLACK RACER, *Zamenis constrictor*, which is uniform black above, and the yellowish-brown COACH WHIP, *Zamenis flagelliformis*, both of North and Central America, are the largest of the New World species, attaining a length of over seven feet. The former snake is particularly savage in its disposition, descending from the trees to attack persons passing at some distance away from it. The Coach Whip is more gentle.

Coluber, which embraces nearly fifty species of constricting snakes, is represented in Europe, Asia, and North and Tropical America. In these snakes the teeth in the upper jaw are equal in length. The head, which is somewhat elongate, is distinct from the neck; the eye is moderate or rather large, and provided with a round pupil. The body and tail are very elongate; the scales are smooth or feebly keeled.

The FOUR-LINED SNAKE, *Coluber quatuorlineatus*, which inhabits South Italy, Dalmatia, Greece, Hungary, and Southern Russia, is the largest of all European snakes, attaining a length of over eight feet. The colour of the adult is dark or light brown, with four black longitudinal bands; in the young the ground colour, which is always of a pale fawn, is spotted with black, the spots disappearing gradually with age, being replaced by the black streaks. The scales on the back, except the outer row, are feebly but distinctly keeled. This snake, which frequents both

dry and marshy localities, is comparatively slow in its movements, and is easily captured; it does exceedingly well in captivity, better, in fact, than any other European snake, becoming very tame and feeding from the hand. It feeds principally on birds and mammals; it is also fond of eggs, which, being an expert climber, it is able to procure from the nests. The eggs, six to fifteen in number, are laid in July and August, and hatched the following month.

The ÆSCULAPIAN SNAKE, *Coluber longissimus*, which is distributed throughout Italy and South-Eastern Europe, and is also found in certain parts of Central and Northern Europe, as far north as Denmark and Poland, has been supposed to be one of the snakes worshipped by the Romans, and its occurrence in various Northern and Central localities, which were once Roman thermal stations, has given rise to the supposition that their presence in such localities is due to importations in the temples of Æsculapius; there is, however, probably more reason to assume that the disconnected habitat of *C. longissimus* indicates a species once more generally distributed in Europe, and now in process of extinction in the Northern and Central parts. In colour this snake is yellowish or dark olive above, some of the scales with whitish spots or lines which may form a network; the young have dark brown dorsal spots, which form a number of longitudinal series, and a yellow collar like our Common Grass Snake. The Æsculapian Snake usually inhabits woods or meadows. It is vicious when freshly captured, but soon becomes amenable to captivity, and feeds with some regularity on small mammals. Its period of hibernation is remarkable for its length, extending from the beginning of October

until May. In spite of its sensitiveness to cold it also avoids excessive heat, and captive specimens should on no account be exposed in summer to the full rays of the sun. The eggs, few in number, five or six, are deposited in hollow trees, holes in old walls, or in dung-heaps, in July, and are hatched in September. The Æsculapian Snake reaches six feet in length; specimens of over four feet, however, may be considered unusually large.

The LEOPARD SNAKE, *Coluber leopardinus*, of slender form, rarely exceeding three feet in length, is a beautiful creature which inhabits Southern and South-Eastern Europe. The typical form is pale brown above, with a dorsal series of reddish-brown or scarlet, dark-edged, transverse spots and a lateral series of smaller black spots. In some specimens (variety *quadrilineatus*) the dorsal spots are replaced by brown or red, black-edged stripes, giving the snakes an appearance very different from that of the typical form. The Leopard Snake, an agile climber, spending most of its existence on low bushes, feeds on very small mammals, birds, and occasionally on lizards. A decidedly viciously disposed creature, this snake does not stand confinement, captive specimens seldom living for more than a year, especially when kept at a high temperature. The eggs, which number two to five, are probably laid late in the summer, as specimens in the Zoological Society's Gardens, upon which I kept observation, paired in the beginning of July.

The LADDER SNAKE, *Coluber scalaris*, another European species, inhabiting the South of France and the Pyrenean Peninsula, may be easily recognized by its strongly projecting pointed snout. It reaches a maximum length of four



Dark Green Snake, *Zamenis gemonensis*.



Rat Snake, *Zamenis mucosus*.

(a)



(b)



(c)



(a) Æsculapian Snake, *Coluber longissimus*.
(b) Leopard Snake, *Coluber leopardinus*.
(c) Four-lined Snake, *Coluber quatuorlineatus*.

feet. In the young the pale brown or yellowish ground colour is ornamented with regular H-shaped black markings along the middle of the back, these disappearing with age, being replaced by a pair of brown stripes which extend along the back. This snake, which is unusually bad-tempered and bold, is common in the vineyards of the Mediterranean parts of France, while in the Spanish Peninsula it most often frequents forest districts. The eggs, about eight in number, are very large, measuring about two inches by two-thirds of an inch.

In the STRIPED SNAKE, *Coluber tæniurus*, a ground snake which is found locally all over China and the Eastern Himalayas to the Malay Peninsula, Sumatra, and Borneo, the head and upper parts are grey-brown above, while a dark stripe runs along each side of the belly and the tail. In the Malay Peninsula, however, where it is found in some of the limestone caves, living in complete darkness, feeding on bats, it is very pale yellow in colour, harmonizing most perfectly with the colour of its surroundings, even the dark band along the tail, which is greyish, resembling a crack or ridge, such as is seen on the walls. Upon the dark mud of the ground the snake is conspicuous, but when lying on a ledge or reared erect along a wall of the cave, it is very easily overlooked, and no colouring could be more suited to its surroundings.

The Fox SNAKE, *Coluber vulpinus*, which inhabits the United States east of the Rocky Mountains, derives its name from the fact that freshly captured individuals eject from their anal glands a pungent secretion, the odour of which has been compared to that which impregnates the cage of a captive fox. The light brown ground colour of

this species is blotched with chocolate brown, the blotches extending from the head to the tail. The Fox Snake, a rather viciously disposed species, will, when provoked, vibrate the tip of its tail, which, when striking twigs, dead leaves, or similar objects, produces the rattling sounds which are usually associated with the rattlesnake. It is a ground loving species, and will seldom ascend trees; an average sized specimen measures about four feet in length.

The CHICKEN SNAKE, *Coluber obsoletus*, a very arboreal snake, attaining a length of six feet, has a more southern distribution than the preceding species. Although in captivity it may be fed exclusively on small mammals, it is very partial to birds and their eggs, and derives its name from its habit of stealing young fowl from poultry farms.

This snake is subject to many colour variations; the typical form is uniform brown or black above, while in the variety *spiloides* the ground colour is relieved by large dark brown spots. The variety *quadrivittatus* bears a striking similarity to the European Four-lined Snake, the brown or yellow colour being striped with four longitudinal blackish bands. The young of all the Chicken Snakes are blotched, as in the adult of the variety *spiloides*, the blotches, except in the case of the latter variety, disappearing with age.

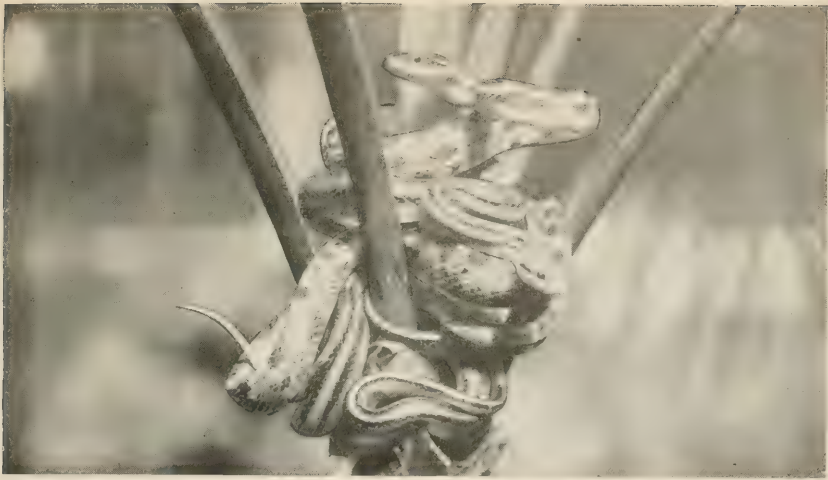
The CORN SNAKE, *Coluber guttatus*, one of the handsomest of all snakes, so called on account of its abundance in cornfields, where it hunts for the small rodents upon which it lives, is another common North American species, which does well in captivity. It is yellowish or pale brown above, with a dorsal series of red, black-edged spots; the belly is yellowish, with large squarish black blotches.

The BULL SNAKE and PINE SNAKE, *Coluber melanoleucus*, are large, robust snakes, differing from other members of the genus in the very prominent snouts. The scales along the middle of the body are strongly keeled. They inhabit the dry pine forests of the greater part of North America and Mexico, and appear under two very distinct colour varieties. The typical form of the Eastern States, more generally referred to as the Pine Snake, is milky white above, with a dorsal series of large black blotches, which, on the anterior part of the body, are often confluent; posteriorly, however, they are always separated from each other by wide interspaces. In the Bull Snake, *C. melanoleucus*, variety *sayi*, the blotches, which are much more numerous, are set more closely together on a reddish or yellowish ground colour. The popular name of this snake is derived from the fact that when excited or annoyed it produces loud bellowing sounds, which, it is said, may be heard at distances of nearly one hundred feet away. The production of these sounds, which have also been compared to distant thunder, is usually explained by the fact that in this snake the glottis is produced into a movable flap, the *epiglottis*, which, when the air contained in the lungs is expelled, produces an increased vibration. It may be mentioned, however, that, as previously stated, the Indian Rat Snake, in which the epiglottis is not developed, produces equally loud and similar sounds. Although, according to Ditmars and other authors, these snakes are generally bad-tempered and refuse food in captivity, the numerous specimens kept by the writer were all gently disposed and remarkable for their voracity, three Pine Snakes and one Bull Snake, which share a cage at the

time of writing, having, in the course of the past year, consumed between them no less than 220 mice, 40 rats, and one guinea-pig.

The genus *Coronella*, very similar to *Coluber*, but with the maxillary teeth increasing in size posteriorly, embraces twenty species, represented in different parts of the northern hemisphere. The head is not very distinct from the neck; the eye, which is small, has a round pupil. Their prey, as in the case of the snakes of the preceding genus, are seized constrictor-like and crushed by the coils of the body.

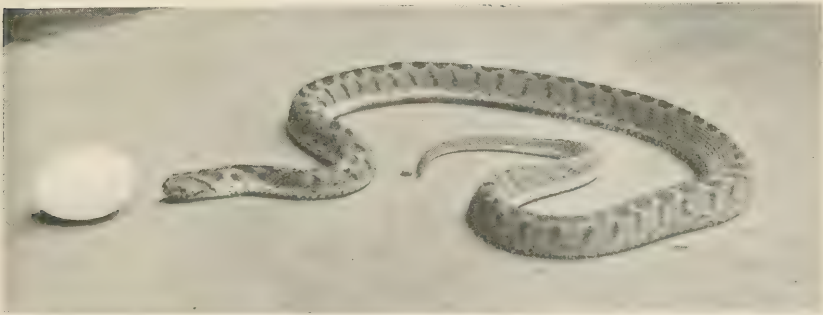
The SMOOTH SNAKE, *C. austriaca*, which derives its name from the absence of keels on the scales of the back, such as we see in the Grass Snake and the Common Viper, occurs in three of our southern counties, namely, Surrey, Hampshire, and Dorsetshire, in localities likewise inhabited by the Sand Lizard, upon which it preys, and over the greater part of Europe, as far north as Scandinavia. It bears a certain superficial resemblance to the Viper, its colour being grey or reddish-brown above, with usually four series of spots along the body, one pair on the back, and one on each side; a large very dark blotch on the back of the head frequently sends off two branches, which may be confluent with the series of dorsal spots, and a dark streak is constant, on each side of the head, passing through the eye. The lower parts are brown, red, or orange, speckled with black and white. Although its resemblance to the Viper is in reality not very marked, those who have difficulty in distinguishing it need only observe the pupil of the eye, which is round, and not a vertical slit, as in the case of the Adder. The Smooth Snake, which seldom



(a)



(b)

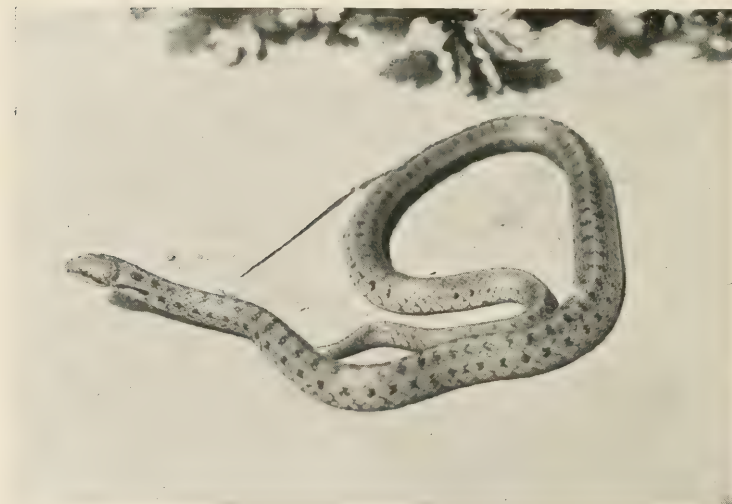


(c)

- (a) Chicken Snakes, *Coluber obsoletus*.
 (b) Pine Snake, *Coluber melanoleucus*.
 (c) Egg-eating Snake, *Dasypeltis scabra*.



King Snake, *Coronella getula*.



Smooth Snake, *Coronella austriaca*.

exceeds two feet in length, grows exceedingly fast, as two specimens in my possession grew from eight to fifteen inches within a period of only nine months, a remarkable rate when we take the snake's maximum length into consideration. Although doing well in captivity, feeding on lizards, it never loses its habit of biting, and gently fastens its jaws into the hand that holds it, without snapping, hissing, or, in fact, giving any form of warning. The snake is ovo-viviparous, the broods, which are produced in August and September, consisting of six to twelve young, measuring about five inches in length.

The SOUTHERN SMOOTH SNAKE, *C. girondica*, inhabits the South of France, Spain, Portugal, Italy, and Sicily, occurring in some localities along with *C. austriaca*. Its colour is brown, grey, or yellowish above, with dark or blackish spots or transverse bars, and with a U-shaped marking situated on the neck; the principal distinction, however, lies in the coloration of the lower parts, which are yellow or red, with squarish spots, often disposed in two longitudinal series. The habits of this species differ somewhat from that of its commoner congener, being more or less nocturnal, seldom showing itself in the day, but leaving its retreat usually only after sunset. It is very slow in its movements, and consequently crushed specimens are not infrequently encountered on paths and roads. It differs also in being extremely gentle, never biting. Like the preceding species it frequents dry and usually sandy localities, feeding almost entirely upon lizards. Its mode of reproduction is unknown.

The KING SNAKE, *C. getula*, of North America, an oviparous species, which reaches a length of over six feet, is

one of the most intelligent of snakes, learning to recognize its master and feeding from his hand. This handsome creature, which is black in colour, marked with round yellow spots or with longitudinal or transverse yellow or white bands, sometimes forming annuli round the body, is extremely active and hardy, and, if kept at a sufficiently high temperature, may be considered the most satisfactory of all snakes from the point of view of captivity. The King Snake feeds on mammals, birds, lizards, and other snakes, the latter, in fact, being preferred to any other food. Mr. Jennison informs me that those in the Belle-Vue Gardens at Manchester are fed regularly on eels, a fact of considerable interest, as no other reptile-eating snake will make a meal off fish, and the question arises as to whether or not the King Snakes, in accepting such prey, are not imposed upon by the elongate form of the fish, and do not regard them as members of the order to which they themselves belong. King Snakes become very excited at feeding time, and when several individuals are kept together in a small cage, two specimens will frequently seize upon their prey at opposite ends, often with the same tragic results as previously related concerning the Boa Constrictors. On one occasion such an occurrence took place at our Zoological Gardens, and a fatal termination was only averted in the nick of time. The keeper whose duty it was to keep a watch on the cage in which five large King Snakes, all over four feet long, were feeding, having been called away, found, on his return a few minutes later, that one of the five snakes was missing; on closer investigation, however, about three inches of the tail of the missing specimen was found to be protruding

from the largest occupant of the cage, who, after some difficulty, was made to disgorge his companion. The most remarkable point, however, in connection with this incident lies in the fact that the snake that had undergone the unpleasant experience was not only quite well and active on its release, but actually went on feeding and devoured a couple of mice within five minutes of being disgorged. The King Snake wages war against all other snakes, and is decidedly useful, inasmuch as it makes no exception of the rattlesnakes, moccasins, and other deadly American species, to the poison of which it is immune. The snake is usually found in moist or shady localities, but does not often take to water or climb trees.

The snakes of the North American genus *Heterodon*, known as the HOG-NOSED SNAKES, on account of their turned-up snouts, are very viperine in appearance, having short and stout bodies and very flat and triangular heads. The raised snout is capped with a strong triangular shield, which enables them to excavate in the sand of the dry pine districts they inhabit. Although they very seldom bite, the Hog-nosed Snakes take up a most threatening attitude when disturbed, hissing violently, spreading out the anterior ribs, and simultaneously flattening out the skin of the fore part of their bodies.

The COMMON HOG-NOSED SNAKE, *H. platyrhinus*, of the United States, east of the Rocky Mountains, which is subject to great variation in colour, is generally of a dusky grey, marked with a triple series of dark blotches, those of the vertebral series being very large and separated from each other by light interspaces. In Carolina and Georgia a variety occurs which is entirely black above, the creature,

when on the defensive, having a specially sinister appearance. Many specimens of this snake, having assumed their threatening attitude to no effect, suddenly turn on their backs and throw themselves into violent contortions, rolling over and over as if in the greatest pain, and finally remaining on their backs as if dead. Mr. R. L. Ditmars, in his book the *Reptiles of the World*, tells a most amusing experience which befell him when snake collecting in the Southern States with a number of negro guides. In order to promote respect for himself the author of the story, having come across a large Hognosed Snake, which was regarded as exceptionally noxious by his followers, requested them to form a circle round him and to watch his powers in snake hypnotism, explaining that he would kill it with a few waves of the hand. Making a few mysterious signs over the snake the latter almost immediately shammed dead, to the amazement of the negroes. The circle was then informed that the serpent would be restored to life again, upon which Mr. Ditmars once more made a few signs over the snake, requesting the company to remain perfectly still. After a few minutes the snake, convinced that all danger was over, rolled over and began crawling away. The effect, however, was more than Mr. Ditmars bargained for, for his guides and porters came to the conclusion that his supernatural powers were decidedly uncanny, and dropped away one by one, leaving him stranded in a wild and lawless region.

The eggs of this snake, which number about twenty-five, are deposited in deep holes in the ground. The newly born young show all the characteristics of their parents

as soon as they emerge from the egg, and flatten out the anterior parts of their bodies or feign death according to their individual dispositions.

The WESTERN HOG-NOSED SNAKE, *H. nasicus*, which inhabits the United States west of the Mississippi, and Northern Mexico, is remarkable for the development of the shield covering the end of the snout, which measures nearly a quarter of an inch in length.

Hog-nosed Snakes, in spite of the fact that they live in dry, sandy districts, in captivity, at least, feed entirely on frogs and toads.

Contia, a genus comprising twenty-five small terrestrial and arboreal species, is restricted to North and South America and the temperate parts of Asia. The head, which is very small, is indistinct from the neck; the body is long and somewhat slender, with smooth or keeled scales; the teeth are small and subequal in size.

The SUMMER SNAKE, *C. æstiva*, a very abundant arboreal species inhabiting the United States, east of the Rocky Mountains, is uniform bright green above, harmonizing perfectly with the foliage of the low bushes it lives on. The snake is remarkable inasmuch as it feeds almost entirely on insects, caterpillars, grasshoppers, and spiders being preferred. Specimens kept by the writer would not pick up their food for themselves, but would swallow gentles, spiders, and small strips of meat when these were placed between their jaws.

In the sub-family *Rhachiodontinæ*, of which the EGG-EATING SNAKE, *Dasypeltis scabra*, of Tropical and South Africa is the sole representative, the teeth and gullet are specially adapted for the swallowing of the eggs upon which

this snake exclusively feeds. The adaptation consists in a reduction of the teeth, which are few and minute, so as to permit the passage of the egg, which reaches the gullet unbroken, and where it comes into contact with numerous large and cutting tooth-like processes of the vertebræ in that region, the object of which is to break the shell, the latter being ejected in the form of a pellet some minutes after feeding. In spite of the fact that this creature seldom attains a length of more than two feet, it has not the slightest difficulty in swallowing eggs three or four times the size of its head.

The Egg-eating Snake is pale brown or olive above, usually with large dark brown spots disposed in three longitudinal series; a Λ -shaped marking is constant on the nape. The scales are more strongly keeled than in any other non-poisonous species, and the keels on the lateral scales are much serrated. In captivity it does exceedingly well, provided it be kept under perfectly dry conditions; two specimens at the Zoological Gardens devoured, between them, 124 pigeons' eggs in the course of a year, these being usually taken at night.

The OPISTHOGLYPHA, the BACK-FANGED SNAKES, were all until quite recently regarded as perfectly harmless to man, their poison being considered only of sufficient activity as to paralyse the prey upon which they live. In the last few years, however, this view has been shown to be erroneous, several of these snakes having been proved to be highly dangerous; the lack of respect with which they had been treated in the past was due merely to the fact that on the rare occasions that these snakes have inflicted

a bite, the front teeth only and not the grooved fangs pierced the flesh, the poison therefore not being inoculated.

The members of this group, which are found in almost every part of the tropical and warmer parts of the world, number about 300; they are divided into the following three sub-families—

1. The *Homalopsinæ*, which have valvular nostrils, opening upwards, and are entirely aquatic.

2. The *Dipsadomorphinæ*, in which the nostrils are situated laterally, and in which the dentition is highly developed.

3. The *Elachistodontinæ*, which have the teeth rudimentary.

The snakes of the sub-family *Homalopsinæ* are thoroughly aquatic, a few living in the sea as well as in fresh water, feeding exclusively on fish and crustaceans. Their body is of moderate length, cylindrical, or slightly compressed; the head is thick, and not distinct from the neck; the tail, which is of moderate length, is sometimes more or less prehensile, and sometimes compressed at its base. The nostrils, situated on the upper surface of the head, are provided with a valve, which, as in the case of the Crocodilia, enables them to breath by raising only the upper portion of the head out of the water. All these snakes produce their young alive. Some are gentle in disposition, but cannot be recommended for keeping in captivity, as they invariably refuse food under such conditions.

Hypsirhina enhydris, a very abundant species throughout the greater part of South-Eastern Asia, is remarkable in being very variable as regards form, some specimens being

slender, with a thin neck and a narrow head, whilst others are somewhat stout, with a more or less triangular head.

Cantor, who has kept this species alive, has made the following observations : " Numbers of this species may be seen in all the rivers, as well as in irrigated fields and estuaries, preying upon fishes, which, however, it refuses in a state of captivity. It is of timid and peaceful habits. A large female, after having been confined for upwards of six months in a glass vessel filled with water, brought forth eleven young ones. Shortly after parturition she expired ; two of the young ones also died in the course of about two hours, after having, like the rest, shed their integuments. In length they varied from six to seven inches. The living nine presented a most singular appearance : they remained a little way below the surface of the water, coiling themselves round the body of an adult male which was also kept in the vessel, occasionally lifting their heads above the surface to breathe, at the same time resisting the efforts of the senior to free himself. Fishes and aquatic insects were refused, in consequence of which the young expired from inanition in the course of less than two months."

The sub-family *Dipsadomorphinæ*, the typical back-fanged snakes, of which there are over eighty genera, is represented nearly all over the world ; they are mostly arboreal in habits, feeding on birds and lizards.

Cælopeltis has the maxillary teeth of moderate size and sub-equal, followed, after an interspace, by one or two very large grooved fangs ; the anterior mandibular teeth are strongly enlarged. The head, which is somewhat angular in shape, is distinct from the neck ; the eye is large with a round pupil. The body is elongate, with smooth scales,



Hog-nosed Snake, *Heterodon platyrhinus*.



Hog-nosed Snake, expanding hood.

Cat Snake, *Tarbophis fallax*.



which are more or less distinctly grooved. The genus, which comprises two species only, extends over Southern Europe, South-Western Asia, and North Africa.

The MONTPELLIER SNAKE, *C. monspessulana*, which attains six feet in length, is olive brown, yellowish, or reddish above, with or without dark, light-edged spots; the sides are usually blackish, with whitish dots. The snake, which has a wide range, being distributed in Southern Europe, eastwards to the Caucasus and Persia, lives in low bushes and seems to have a preference for the neighbourhood of human habitations. Although seldom attempting to bite, the poison of the Montpellier Snake is fairly active, its action having been shown to bear a striking similarity to that of Cobra poison. The eggs, four to twelve in number, are laid in July.

In *Macroprotodon*, of Spain, Portugal, the Balearic Islands, and North Africa, the teeth are few and very unequal in size, the two posterior being fang-like and grooved. The genus is represented by a single species, *M. cucullatus*, which bears a striking resemblance to the Southern Smooth Snake, *Coronella girondica*, and with which it is frequently confounded; like the latter snake it feeds almost exclusively on lizards. It is usually considered fairly harmless.

The eight species of the semi-nocturnal genus *Tarbophis*, inhabiting South-Eastern Europe, South-Western Asia, and Tropical and North Africa, have the anterior teeth of the upper jaw longest; a pair of large grooved fangs are situated below the posterior border of the eye. The body is slender and moderately elongate; the eye is rather large, with a vertical pupil.

The CAT SNAKE, *T. fallax*, which inhabits South-Eastern Europe and Northern Syria, is so called on account of the cat-like manner in which it stalks the lizards upon which it feeds. It is greyish above, with numerous black or dark brown blotches, or bars, on the body. According to Eiffe the poison of the Cat-Snake is fairly active; the writer, however, on one occasion received the full bite of this snake without feeling the slightest inconvenience. This snake does not do well in captivity, seldom surviving the winter, but is, nevertheless, imported to this country every spring in very large numbers.

The majority of the slender snakes of the genus *Psammophis* inhabit the arid, sandy districts of Africa and Southern Asia; a few are more or less arboreal, being found on shrubs. The very large fang-like teeth of the middle of the upper jaw are followed, after an interspace, by the grooved fangs.

The NORTH AFRICAN SAND SNAKE, *P. sililans*, known to the Arabs as "the father of stripes," in allusion to the narrow yellow streaks which adorn the back and sides, which are of an olive or brown colour, is the commonest species, and is found in large numbers under stones in sandy, desert areas, where it feeds on lizards and very small rodents. Although its fangs are of a considerable size, its bite merely serves to partly paralyse the small animals upon which it lives.

KIRTLAND'S TREE SNAKE, *Thelotornis kirtlandii*, the only member of its genus, a very arboreal snake, harmonizes in a most perfect manner with the twigs of the bushes upon which it lives. The very elongate body and tail, pinkish-brown in colour, are excessively slender, while the

head, which is likewise much elongate, is bright green above, speckled with lighter, and with a black streak on each side passing through the eye, which is large and has a horizontal pupil. The poison fangs, three in number, are strongly enlarged. When in a state of excitement the neck of this serpent distends all round in a globular fashion, revealing a number of irregular white spots between the scales, which are invisible when the creature is in its normal condition. In spite of its menacing manners it seldom bites.

Dispholidus, represented by a single species, *D. typus*, the BOOMSLANG, inhabits both Tropical and South Africa. The snake, which grows to a length of five feet, is remarkable for its large eyes, its long posterior fangs, and the manner in which it inflates its neck when angry. On the authority of an antiquated classification and the statement of Sir Andrew Smith, in his work on South African reptiles, the snake was until recently regarded as perfectly harmless. Mr. F. W. Fitz-Simmons, director of the Port Elizabeth Museum, a few years ago, however, reported a serious case of the results of the bite of this snake. In November 1907 a number of Boomslangs were being transferred to new quarters in his laboratory, when one of Mr. Fitz-Simmons' assistants, who was carrying a specimen, was bitten in the muscles of his bare fore-arm, just below the elbow joint. It gripped with great power and held on firmly. Mr. Fitz-Simmons disengaged the jaws and suggested treating the wound, but his assistant would not hear of such a thing, believing the snake to be non-poisonous. A short time later, however, a throbbing headache manifested itself, accompanied by oozing of blood from the mucous mem-

branes of the mouth, followed by vomiting. During the night the patient's condition became alarming, and on the following day he was conveyed to the hospital in a state of utter collapse. He rapidly sank, and on the evening of the third day after being bitten his condition was so critical that death was expected before the morning. He lingered on in this state, bordering between life and death, till about the sixth day, when a slight improvement set in, and from this time onwards his condition rapidly improved; it was not until more than three weeks later that he was discharged from the hospital, and over three months from the date of the bite before all effects disappeared. Mr. Fitz-Simmons, who subsequently made numerous experiments on the effects of the bite of the Boomslang on fowls and ducks, found that the bite of this snake will kill birds just as rapidly as does that of the South African Cobra.

The Boomslang, as its Dutch name implies, is chiefly arboreal, feeding on lizards, birds, and their eggs. It varies much in colour, being green, olive, brown, or black above; the young are speckled with darker or lighter spots.

Leptodira has a very wide distribution, being found in Tropical and South Africa and Tropical America, northwards to Texas. The head is most distinct from the neck; the eye is very large, with a vertically elliptic pupil. The body is somewhat compressed. The maxillary teeth gradually and feebly increase in length; they are followed, after an interspace, by a pair of enlarged fangs.

The ANNULATED SNAKE, *L. annulata*, of the West Indies and Tropical South America, frequently arrives in this



Kirtland's Tree Snake, *Thelotornis kirtlandii*.



Long-snouted Tree Snake, *Dryophis mycterizaus*.



Banded Krait, *Bungarus fasciatus*.



Hamadryad, *Naia bungarus*.

country in bunches of bananas, and specimens are occasionally sent to the Zoological Gardens from Covent Garden Market. This snake, which only attains a length of two feet, is reddish-brown above, with dorsal series of large, black blotches, which often form a zigzag band. Although arboreal in habits it feeds exclusively on frogs and fish.

The genus *Chrysopelea*, of South-Eastern Asia, is made up of three species. The head is distinct from the neck; the eye is large, with a round pupil. The body and tail are elongate and somewhat compressed; the scales of the upper surface are smooth or very feebly keeled, while the plates on the belly and tail are keeled and notched laterally. The teeth are sub-equal and all small; the fangs are only very feebly enlarged.

The "FLYING" SNAKE, *C. ornata*, of Ceylon, South India, Bengal, Assam, Burma, South China, and the Malay Peninsula and Archipelago, is specially noteworthy for its habit of taking flying leaps from one tree to another. Captain Flower has observed a specimen leap from an upstairs window of a house, downwards and outwards, on to a branch of a tree, a distance of eight feet, and then crawl away among the foliage. Shelford, who has reported similar performances, took specimens to a height of nearly twenty feet and allowed them to fall several times; after one or two false starts the snakes were felt to glide from the experimenter's hands, straighten themselves out, and, hollowing in their ventral surface as they moved, parachuted to the ground. According to Flower, *Chrysopelea* is very fierce, and always attempts to resist capture by striking and biting furiously, and will frequently, on such occasions, bite into the sides of its own body. The

“Flying” Snake is a constrictor, and feeds chiefly on lizards, Geckos being preferred; it will also, however, occasionally take small mammals, but never frogs. In coloration the snake is very variable; the body may be black or green, handsomely ornamented with yellow, orange, or red; the head is always black, with yellow spots or cross-bars.

Dryophis, another Old World genus of tree snakes, is composed of eight species, all inhabiting South-Eastern Asia. The body and head are much elongate and compressed; the eye is large and provided with a horizontal pupil. Several of the teeth in both jaws are enlarged and fang-like; the poison fangs are likewise large.

The GREEN WHIP-SNAKE, *D. mycterizaus*, which is also known by the name of the Eye-poking Snake, in allusion to its habit of striking at the face of those by whom it is disturbed (the natives believing that it purposely aims at the eyes of its aggressor), is specially remarkable for its long and pointed snout, which terminates in a fleshy appendage. It is uniform bright green in colour, being quite invisible in the bushes and high grass which it frequents. Although often represented as a gentle creature, the few specimens that I have come across were all abnormally vicious, and for the first few days of their captivity persisted in striking wildly at the panes of the vivarium in which they were kept. Its food consists chiefly of lizards, which it invariably seizes behind the neck; it will also occasionally accept frogs, while quite young specimens are said to be insectivorous. This species is viviparous, a large specimen received some years ago in the Zoological Gardens, bringing forth a brood of eight active young.

The PROTEROGLYPHA, the snakes in which the anterior teeth of the upper jaw are grooved, are all very poisonous, their fangs communicating generally with very large poison glands; they inhabit Asia, Africa, and America, and form the bulk of the Ophidian fauna of Australia.

The group is divided into two sub-families—

1. The *Hydrophinae* (sea-snakes), which are easily recognized by their strongly compressed, oar-shaped tails.
2. The *Elapinae* (land-snakes), with cylindrical tails.

The SEA-SNAKES inhabit the tropical parts of the Indian and Pacific Oceans, spending, with one or two exceptions, their entire existence in the sea. Their most striking feature is their compressed paddle-shaped tail, which in some species is prehensile, enabling the serpents to secure a hold by twisting this organ round sea-weeds and other objects. Their nostrils, which are small, crescentic openings with a valve interiorly, are placed on the top of the head, and are opened during respiration and closed when the creature dives. In most Sea-Snakes the scales are feebly overlapping, while, with the exception of the snakes of the genus *Platurus*, which occasionally go on shore, the plates of the under-surface are rudimentary or entirely absent. The head is very small and covered with large shields. The eye, which is also small, has a round pupil, which contracts when the snake is out of the water, the creature, under such circumstances, becoming partially blinded. Sea-Snakes shed their "skin" at frequent intervals, the epidermis not coming off entire, but peeling off in pieces as in lizards. Their prey, which consist entirely of fish and crustacea, are killed by the action of the poison before being swallowed. The greatest size

attained by any Sea-Snake is only ten feet in length. Of course we have heard of the gigantic "sea-serpents," but from the little we know about this problematic monster, it is certainly not a snake.

The *Hydrophinæ* are divided up into ten genera and about sixty species; they are all viviparous, the female visiting the rocks of small islands to give birth to her

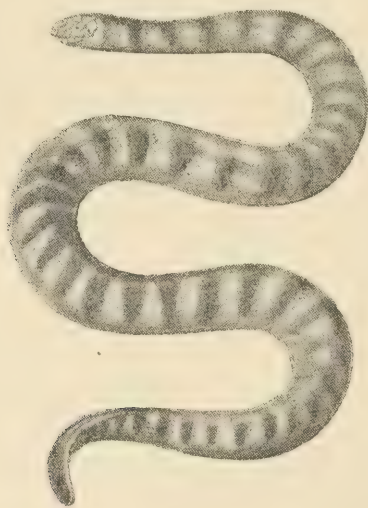


FIG. 8.—Sea-snake, *Enhydra valakadien*.
(After Boulenger.)

offspring, which she protects for the first few days of their existence by coiling round them.

Elaps, with thirty species, the largest genus of the sub-family *Elapinæ*, is distributed over the Southern United States and Central and South America. The body is usually much elongate and cylindrical; the tail is short; all the scales are smooth. The head is quite



Indian Cobra, *Naia tripudians*.



Indian Cobra, *Naia tripudians*, var. *fasciata*.



Black and White Cobra, *Naia melanoleuca*.

small, rounded, and not at all distinct from the neck; the eye is likewise small, and with a round pupil.

In spite of their small size, very few attaining a length of more than three feet, these snakes have a very highly developed poison apparatus, and their bite has on many occasions produced fatal results.

The HARLEQUIN SNAKE or CORAL SNAKE, *E. fulvius*, so called from the fact that its body is annulated black and red, or black, yellow, and red, has a wide distribution, occurring in Eastern North America, Mexico, and Central America. According to Dr. Loennberg, in Florida the Coral Snake is perhaps the most dangerous snake, as, although quite as poisonous as the large rattlesnakes and moccasins, it is generally regarded as harmless, being, in consequence, caught and often roughly handled, with the result that the snake bites, and human life is endangered. The majority of snakes, when biting, throw the head forward, bite, and immediately withdraw, but the Coral Snake, after having bitten, hangs on like a bull-dog, and has to be pulled away from the wound. *E. fulvius* lives in damp localities, and is somewhat of a burrower, being frequently met with when the ground is dug up. It feeds on cold-blooded animals—lizards, frogs, and small snakes.

The semi-nocturnal snakes known as KRAITS, which make up the genus *Bungarus*, all inhabit South-Eastern Asia. The body and tail are rather short, and often with a dorsal keel; the head, which is indistinct from the neck, is small, with the snout obtusely rounded; the scales are smooth, enlarged and hexagonal in shape on the vertebral line. Although the fangs are comparatively small, the poison glands are as well developed as in the cobras.

The Kraits are very quiet creatures, never biting unless seriously molested, and when attacked do not attempt to retreat, but merely hide their heads under the coils of their body. They feed principally on other snakes, and will devour specimens as large as themselves; frogs and toads are occasionally accepted.

The COMMON KRAIT, *B. candidus*, is dark brown or bluish-black above, with narrow, transverse white streaks or with small white spots, or alternately barred with dark brown and white. It has a remarkably wide distribution, inhabiting the grassy plains of India, Burma, Southern China, and the Malay Peninsula and Archipelago. Major Wall says that it seems to be most abundant in populated districts, and frequently domiciles itself, for choice, in human habitations. Sir Joseph Fayrer mentions an instance where, after a night's journey in a palanquin, a lady, in taking out her things on arrival at her destination, found a large Krait, which had been her travelling companion all night, coiled up under her pillow. Although it rarely inflicts a bite, when it does so, unless proper measures are instantly taken, the result is likely to be fatal. A case has been recorded concerning four men who allowed themselves to be bitten by a three-foot-long Krait, under the impression that the snake was harmless. Bitten at night-fall, three died before dawn, while the fourth expired at noon the next day. The Common Krait, which grows to a maximum length of four feet, is said to attain a greater length in the northern parts of its habitat than in the southern. The eggs, eight to twelve to a clutch, are deposited in April and May; the mother has been observed to remain coiled round them until they are ready to hatch.

The BANDED KRAIT, *B. fasciatus*, a very nocturnal snake, which frequents jungle districts in preference to grassy plains, agrees in its distribution with the Common Krait; it is most vividly marked with bright yellow and black annuli. It is even more sluggish than the common species, and will not, even when attacked, make any attempt to defend itself. Its poison is somewhat less virulent than that of *B. candidus*.

In the true COBRAS, genus *Naia*, the head is but slightly distinct from the neck; the eye is rather large, with a round pupil. The body is cylindrical; the tail is moderately long; the scales are smooth. The fangs are not very large. The neck is in all the species dilatable to a greater or less extent, the expansion being produced by the distension of the skin, supported by the anterior ribs, which are longer than those following. The Cobras, ten in number, inhabit Africa and all the tropical and semi-tropical regions of Asia. Although essentially terrestrial, they are all fond of water, and will remain in it for hours partly submerged.

The INDIAN COBRA, *N. tripudians*, which is also known by the Portuguese name of Cobra de Capello (Hooded Snake), when irritated, expands its neck very extensively. The markings on this snake, which are light or dark brown or black in colour, vary considerably, and the various forms would be, but for the absence of demarcation lines between them, regarded as valid species. The typical form has a curious spectacle-shaped marking on the upper surface of the neck, which characterizes the cobras of Southern India and Ceylon. There are, however, forms without the spectacle, the latter being replaced, in the variety *fasciata*, of Northern India and South-Eastern Asia, by a

whitish, black-edged ring or mask-shaped figure, while in the black varieties, *sputatrix* and *leucodira*, also of South-Eastern Asia, the marking on the hood is entirely absent.

This cobra, one of the most dangerous of snakes, its bite producing death, often within a couple of hours, is somewhat nocturnal, and usually becomes active only towards dusk, when it leaves its burrow to hunt for the small mammals, frogs, and eggs upon which it subsists. Although capable of going for long periods without food, the Indian Cobra, when in good health, is remarkably voracious, a specimen at present living in the Zoological Gardens having consumed 130 mice in the course of the last year, devouring on occasions as many as eight mice at a single meal. The eggs, about a dozen in number, are deposited under decomposed leaves.

In spite of the enormous numbers of deaths caused yearly by this snake, it is still regarded in many parts of India as a crime to kill a Cobra, its presence in a house being considered by the natives to be an omen of prosperity.

The KING COBRA or HAMADRYAD, *N. bungarus*, the largest, boldest, and most dangerous of all venomous snakes, is dreaded, not without good reason, for when disturbed it does not content itself, like *N. tripudians*, with merely sitting up and expanding its hood, but will almost invariably attack. The Hamadryad, which attains a length of fifteen feet, in spite of its wide distribution (India, Burma, Indo-China, Southern China, and the Malay Peninsula and Archipelago), is fortunately nowhere very common. The coloration is yellowish-brown, olive, or blackish above, with or without dark cross bands; its

hood, which is almost invariably banded, is not expansible to nearly so great an extent as in the Indian Cobra.

The Hamadryad feeds exclusively on snakes, small pythons, kraits, rat-snakes, and the common cobra entering into its bill of fare.

Captain G. H. Evans, in the *Journal of the Bombay Natural History Society*, tells the following story, told him by an intelligent Burmese who one day stumbled upon a nest of these serpents and was chased by the female. "The man fled with all speed over hill and dale, till, reaching a small river, he plunged in, hoping he had then escaped his fiery enemy; but, lo! on reaching the opposite bank, up reared the furious Hamadryad, her eyes glistening with rage, ready to bury her fangs in his trembling body. In utter despair he bethought himself of his turban, and, in a moment, dashed it upon the serpent, which darted upon it like lightning, and for some moments wreaked its vengeance in furious bites."

The bite of the Hamadryad produces death in man in from one to two hours. According to Nicholson, an elephant which he saw bitten by this snake died within three hours.

N. melanoleuca and *N. nigricollis*, both of Tropical Africa, are remarkable for their power of ejecting their poison at a considerable distance, and are consequently both known to the natives as "spitting snakes."

In the RINGHALS, *Sepedon hæmachates*, of South Africa, the only representative of the genus, which is separated from the true cobras by its keeled dorsal scales, the "spitting" habit is highly developed, for, when disturbed, the snake invariably sits up, dilates a very large hood, and ejects

its poison to a distance of several feet. Freshly imported specimens at the Zoological Gardens, for the first few weeks of their captivity, covered the glass panes of their cage with venom in their attempts to "spit" at the visitors. Unlike the "spitting" cobras, which only occasionally "spit," the Ringhals invariably do so when angry, and at the Gardens, when the door of the cage in which these snakes are kept has to be opened for the purpose of introducing food, etc., motor goggles are always worn for the protection of the eyes.

In the snakes of the semi-arboreal genus *Dendraspis*, of Tropical and South Africa, which are popularly known as MAMBAS, the fangs are very large. The body and tail are slender and elongate, and the scales are long, narrow, and smooth.

D. angusticeps, of Western, Central, and South Africa, which grows to a length of eight feet, is the commonest species. The colour is uniform green, olive, or black. This Mamba, which inhabits hollow trees and is often found coiled up among the branches, is a remarkably active, bold, and aggressive snake, especially the black form, and, like the Hamadryad, is said to pursue when disturbed, many being the stories told of hairbreadth escapes from this, probably the deadliest of all snakes. Mambas feed principally upon birds; specimens of *D. viridis*, a species restricted to West Africa, kept by the writer, would occasionally accept mice as well.

The Ophidian fauna of Australia consists principally of snakes of this family, all of which are very dangerous.

The DEATH ADDER, *Acanthophis antarcticus*, one of the most dreaded snakes of the Australian continent, is the

sole representative of the genus, which also occurs in the Moluccas and New Guinea. It has a very viperine appearance, and was, in fact, long placed amongst the vipers. The head is distinct from the neck. The eye is small, with a vertically elliptic pupil. The body, the scales upon which are keeled, is stout. The fangs are large. The colour of this snake is yellowish or reddish-brown, with dark cross-bands.

The Death Adder has as nervous a disposition as the cobras, and when disturbed flattens out its entire body, raising its head slightly as if to strike. According to Krefft, the young, ten to fifteen in number, begin to snap right and left as soon as they have broken through the egg-covering.

The VIPERS, family VIPERIDÆ, are the most highly modified of poisonous snakes, the maxillary bone, to which the poison fangs are fixed, being much shortened and movable vertically, a mechanism by means of which the fangs, which are usually of very large size, may be raised and lowered. The family is divided into two well-defined sub-families, the Vipers proper (*Viperinæ*) inhabiting Europe, Asia, and Africa, and the Pit-Vipers (*Crotalinæ*), of Asia and America, the latter being distinguished from the former by the presence of a deep pit, probably a sensory organ, situated on each side of the snout, between the nostril and the eye.

The type genus *Vipera* comprises about twenty species, which are distributed over Europe, Africa, and the greater part of Asia. The head, which is distinct from the neck, is covered with scales or small shields. The body and tail

are short and cylindrical, and covered with keeled scales. The rather small eye is provided with a vertical pupil. Six species of Vipers occur in Europe, which merge into each other in such a complete manner that the naming of certain specimens is often a matter of some difficulty.

The COMMON VIPER, *V. berus*, the only poisonous snake inhabiting the British Isles, where it may generally be recognized by a dark, zigzag band which runs along the centre of the back, although certainly dangerous, has seldom produced death in man. The zigzag band is almost invariably present in British specimens, but the pattern varies very considerably on the Continent, where the band may be either broken up into oval spots or transverse bars, or may be entirely absent. The snake is often stated to bear its initial on the back of the head, but this V-shaped marking is likewise not constant.

The Viper, which, in England and Scotland at least, frequents dry woods and heaths, awakes from hibernation quite early—towards the end of February or the beginning of March, and commences to feed the following month. Its principal food consists of young birds nesting on the ground, voles, field-mice, and lizards; in captivity it, unfortunately, will hardly ever feed, and dies in a very short time from starvation. Up to twenty young are brought forth in July and August, in a very active condition, the newly born snakes throwing back their heads and attempting to strike as soon as they have left their mother. On the approach of a human being, the young frequently disappear with great rapidity, this having given rise to the statements that, when in danger, the young snakes are swallowed by their mother. This belief, however, is not



The Ringhals, *Sapedon hamachates*.



Green Mamba, *Dendraspis viridis*.

(a)



(b)



(c)



(a) Night Adder, *Causus rhombeatus*.
(b) Russell's Viper, *Vipera russelli*.
(c) Some tame British Adders, *Vipera berus*.

accepted by the majority of naturalists, as the phenomenon may be explained by the fact that, when disturbed, the young escape into the herbage with such speed that the spectator, who is the victim of an optical delusion, imagines that they must have taken refuge down the throat of their mother. On the female being opened she is found to contain fully developed and active young, which are, however, but part of the brood about to be expelled. Some years ago the *Field* newspaper offered quite a substantial reward to any one producing conclusive evidence of a viper having swallowed her young; the reward was never claimed.

Although somewhat savage when first captured, the Common Viper often becomes quite tame, and the writer has often had specimens which allowed themselves to be handled without showing any signs of resentment. The largest recorded specimen of this snake measures twenty-eight inches; about twenty inches is the average length.

The LONG-NOSED VIPER, *V. ammodytes*, common in South Austria, Hungary, and the Balkan Peninsula, is characterized by the snout, which is produced into a long, fleshy appendage, covered with scales. It grows to a much larger size than the common species, specimens of over two feet being of common occurrence, and, unlike *V. berus*, does well in captivity, feeding on mice, small rats, and lizards.

ORSINI'S VIPER, *V. orsinii*, which has a somewhat pointed snout, but no fleshy appendage, occurs in the French Alps, Italy, Bosnia, Lower Austria, and Hungary. The typical form feeds almost entirely on lizards, but the variety *macrops*, restricted to Bosnia, although endowed with as

perfect a poison apparatus as any of the other European Vipers, feeds entirely on grasshoppers and other insects, and freshly captured specimens have been observed to disgorge what proved to be balls made of the remains of hundreds of insects. Orsini's Viper is said to be a very gentle snake. In Lower Austria the village boys have been seen playing with this viper, and Werner states that, at Laxenburg, where the species occurs in very great abundance, no accident from snake-bite has ever been heard of.

The distribution of some of the European Vipers is very puzzling. The Common Viper, which is abundant in Northern and Central France, is replaced by the Asp Viper, *V. aspis*, in Southern France, and the Pyrenees, while in Spain and Portugal it reappears to the exclusion of the latter species. Although common in the mountains in most parts of Europe, the Common Viper in Italy is more restricted to the plains, the Asp Viper being the commoner in the Alps.

Orsini's Viper has also a curious distribution, being a mountain form in Italy, Bosnia, and Herzegovina, whilst in Austria and Hungary it is restricted to the plains.

RUSSELL'S VIPER, *V. russelli*, or 'Tic-polonga, as this large and justly dreaded snake is known in Ceylon, is found in hills, as well as in the plains of India, Ceylon, Burma, Siam, and Sumatra. In this, a more or less nocturnal species, frequenting open country, rarely the jungle, the fangs reach their maximum development. The coloration is very handsome, being, above, of a very pale brown, with three longitudinal series of black, light-edged rings, which encircle reddish-brown or even red spots, those of the

vertebral column frequently forming an undulous band. The large head, which is most distinct from the neck, has large symmetrical dark markings, and two light lateral bands uniting on the snout. When disturbed this viper, which is usually of very sluggish habits, hisses violently with each inhalation and expulsion of the breath, the hissing sounds produced being clearly audible at a distance of thirty feet. Although it seldom attacks, when it does so it will throw itself at its enemy with such force that the body, in the act of striking, actually leaves the ground. Russell's Viper brings forth about twenty-five living young, which are frequently still surrounded by their leathery covering at birth, thus of a brood of sixteen born recently in Regent's Park, four were hampered by the membrane. Its food consists entirely of mammals; adult specimens will not eat snakes, although, according to Wall, the young will sometimes devour one another. Many authors state that this snake will not feed in captivity; the numerous examples at the Zoological Gardens, however, feed with remarkable regularity, devouring on an average a dozen mice a month each.

Russell's Viper is even more venomous than the majority of Cobras, its bite killing fowls in from thirty seconds to a few minutes, dogs in from ten minutes to four or five hours, and man in under twenty-four hours.

In *Causus*, of Tropical and South Africa, of which four species are known, the head is scarcely distinct from the neck, and is covered with large symmetrical shields. The body, which is moderately elongate, is covered with either keeled or smooth scales. The tail is short. The eye is rather large, with a round pupil. The poison gland is

remarkable in being very elongate, and is situated at the side of the neck between the skin and the body muscles ; it is produced along each side, terminating in front of the heart, which is situated about the anterior third of the body.

The commonest and best known species is the NIGHT ADDER, *C. rhombeatus*, which has a wide distribution in Tropical as well as South Africa : it grows to a length of nearly three feet. It is olive or pale brown above, with a dorsal series of large rhomboidal dark brown spots ; a large dark, Λ -shaped marking is situated on the back of

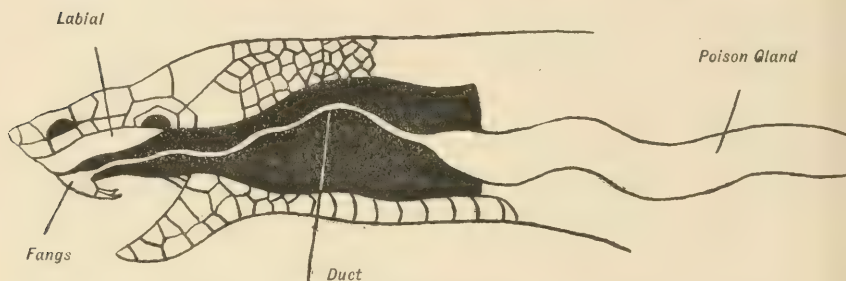


FIG. 9.—Head and neck of *Causus resimus*.

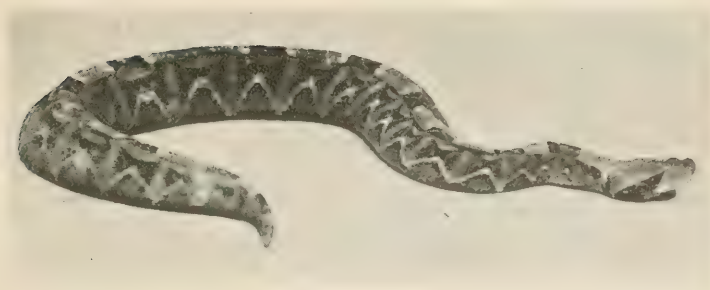
(After Werner.)

the head. The snake, which, in spite of its popular name, is by no means essentially nocturnal, feeds principally on frogs, of which it devours large quantities, a large specimen, living at the time of writing in the Zoological Gardens, consuming on an average about twenty frogs a month. When angry the Night Adder has the peculiar habit of dribbling its venom from the point of its fangs. Unlike the majority of vipers, the members of the genus *Causus* do not produce active young, but lay eggs, which are deposited under decomposing vegetable matter.

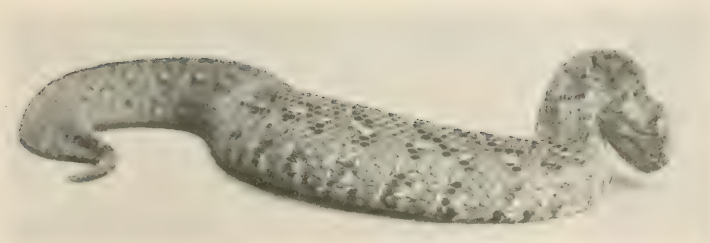
The snakes of the genus *Bitis*, restricted to Africa, have



(a)



(b)



(c)

- (a) Nose-horned Viper, *Bitis nasicornis*.
 (b) Gaboon Viper, *Bitis gabonica*.
 (c) Puff Adder, *Bitis arietans*.

a very large head, which is covered with small scales, and which is very distinct from the neck. The body and tail are short and very stout, and covered with keeled scales. The eye is moderate or large, with a vertical pupil. The fangs are very highly developed.

The PUFF ADDER, *B. arietans*, of Southern Morocco and Somaliland to the Cape of Good Hope, and also of Southern Arabia, derives its name from its loud hissing, which has been compared to puffing; the sounds produced, however, are not nearly so intense as those of Russell's Viper of India. The snake, which grows to a length of three and a half feet, is yellowish or pale brown above, marked with regular, chevron-shaped, dark brown or black bands.

The GABOON VIPER, *B. gabonica*, and the NOSE-HORNED VIPER, *B. nasicornis*, both found in East and West Africa, are undoubtedly the most evil-looking of all serpents, their heads being very distinct from their rather narrow necks, while their snouts are surmounted by a pair of horns covered with scales; in the case of the Nose-horned Viper the horns may measure over half an inch in length. Both these snakes are very gaudily coloured. *B. gabonica*, of which a record specimen, measuring exactly five feet in length and weighing twelve pounds, is at present living in Regent's Park, is pale yellowish-brown above, with numerous hour-glass-shaped dark markings, while *B. nasicornis*, which does not attain quite so large a size, is purplish or reddish above, with angular black, yellow, and white markings.

The brown and white hornless BERG ADDER, *B. atropos*, is a mountain form, inhabiting South Africa, where it feeds

almost entirely on lizards. Fitz-Simmons says that it cannot be kept in captivity, as, when taken away from its natural conditions, it refuses food, declines in health, and dies after a very short period.

All the members of the genus *Bitis* are very inert and sluggish, but are, nevertheless, much feared on account of their generally fatal bite.

In *Cerastes*, of North Africa, Arabia, and Palestine, the head, which is covered with very small scales, is most distinct from the neck. The eye is rather small, with a vertical pupil. The body is cylindrical; the dorsal scales form straight, longitudinal series with club-shaped keels, which do not extend to the extremity of the scale; the lateral scales are smaller and point downwards. The tail is short. The genus is represented by two species, *C. cornutus*, which often has a pair of large erect, horn-like scales situated above the eyes, and *C. vipera*, in which these "horns" are constantly absent. Both are yellowish or pale brown above, and harmonize with the sand of the desert which they inhabit; neither attain a length of more than two feet.

The HORNED VIPER, *C. cornutus*, is usually found concealed in the sand with only the "horns" of the head visible, and the old writers, to whom this snake was well known, stated that these appendages were intended to entice birds to them, seeing in them a resemblance to grains of barley, or insects. It frequents perfectly dry localities, and its presence, therefore, in the island in the middle of Lake Moeris is most remarkable, as it never enters water. Anderson and other writers state that it feeds exclusively on small mammals, the majority of specimens inhabiting

the holes tenanted by mice and jerboas; specimens at our gardens, however, were also fond of lizards.

When excited this snake moves the coils of the body against one another and makes loud, rustling sounds, which are produced by the friction of the serrated lateral keels.

Horned Vipers with four "horns" are frequently offered for sale by the native snake-catchers, but the extra pair are merely the spines of hedgehogs which have been inserted through the unfortunate creature's head, behind the eye. The poison of this viper is destructive to small mammals, and even to birds as large as a pelican, but is not generally deadly to man.

Echis, likewise represented by two small species, *E. carinatus*, of Africa north of the Equator, and of Southern Asia, and *E. coloratus*, of Egypt, Palestine, and Arabia, differs from *Cerastes* in a narrower head and in the scales of the under-surface of the tail being disposed singly, and not in a double series.

The CARPET SNAKE, *E. carinatus*, by far the best known species, is not confined to arid districts, but is also found in grassy localities, usually under stones and logs. The coloration is pale buff, or greyish above, with one or more series of whitish, dark-edged spots, the outer usually forming eye-spots; a dark, Y-shaped marking is often present on the head. This snake, which averages two feet in length, is very active and highly venomous, accounting, especially in India, for many deaths; it is semi-nocturnal in its habits, and feeds on insects as well as small mammals. Before attacking, which it does by throwing itself forward by a bound for a distance of over a foot, it coils up, producing the rustling sounds in a similar manner to *Cerastes*.

Atheris, of Tropical Africa, is a genus composed of four or five small arboreal species; the very distinct head is heart-shaped and covered with small scales. The body and the prehensile tail, the scales upon which are keeled, are compressed. The fangs are moderately developed. Tree-frogs form the only food of these vipers.

A. clorechis, of West Africa, which at the most grows to two feet in length, is bright green in colour, being perfectly inconspicuous when coiled among the foliage of the branches upon which it lives.

Atractaspis, of Tropical and South Africa, represented by about fifteen small snakes, none of which attain a length of more than thirty inches, are all highly poisonous, the poison fangs being enormously developed, larger in proportion than in any other snake. I was myself on one occasion bitten on the finger by a fifteen-inch-long specimen of *A. irregularis*, and in spite of the fact that one fang only pierced the flesh, and that every endeavour was made to prevent the absorption of the poison, the effects were most pronounced, being felt for several days.

The PIT-VIPERS, sub-family *Crotalinæ*, are inhabitants of Southern Asia and Southern and Central America, and are represented by four genera, which may be distinguished as follows—

A. No rattle.

1. Upper surface of head covered with nine symmetrical shields, *Ancistrodon*.
2. Upper surface of head covered with scales or small shields, *Lachesis*.

B. Tail ending in a rattle.

1. Upper surface of head covered with nine symmetrical shields, *Sistrurus*.

2. Upper surface of head covered with scales or small shields, *Crotalus*.

The pupil is vertical in all four genera. The fangs are always highly developed.

In *Ancistrodon* the body and tail are cylindrical, and rather short and stout. The scales may be smooth or keeled.

The WATER VIPER or MOCCASIN, *A. piscivorus*, extends from Carolina and Indiana to Florida and Texas; it inhabits the neighbourhood of water, being frequently found on the low bushes overhanging rivers and ponds, into which it dives when disturbed. The general colour of this snake is of a chestnut brown above, with a series of about twenty-five indistinct, dark, vertical bars on the sides of the body, which sometimes unite above into an arch. The head is purplish-black above, with a light-edged, dark brown streak passing from the eye to the angle of the mouth.

The Moccasin is not at all particular in the choice of its food, feeding on fish, frogs, mammals, and other snakes. Mr. R. I. Pocock informs me that a specimen which lived some years ago in the Clifton Zoological Gardens was fed entirely on raw meat, which it took from a plate. This snake is very hardy, surviving many years of captivity, a specimen having lived for over twenty-one years in the Paris Jardin des Plantes.

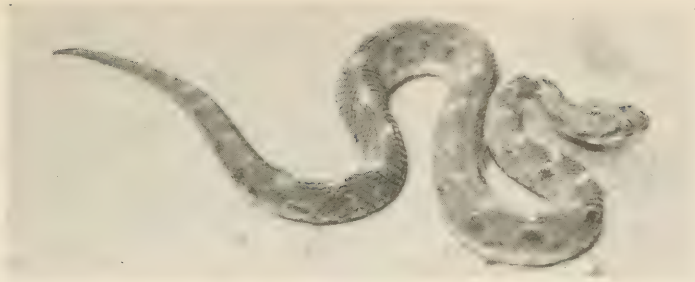
The COPPERHEAD, *A. contortrix*, having about the same

distribution, is more handsome, being yellowish, pinkish, or pale reddish above, with broad, dark brown or brick-red cross-bars, which usually break up on the vertebral line, forming alternating triangles; a dark temporal streak is often present. Although not quite so aquatic as the Moccasin Snake, the Copperhead likewise frequents swampy localities, feeding on frogs and mammals; it will not, however, as far as I am aware, accept fish. It also does exceedingly well in captivity, specimens having lived in Regent's Park for over ten years.

The EASTERN PIT-VIPER, *A. rhodostoma*, of Siam, the Malay Peninsula, Java, and Sumatra, is a beautiful creature, suggestive of a Python in its markings; it is reddish-brown above, with large, angular, dark brown, black-edged spots, disposed in opposite pairs; the lips are pinkish.

In Java, where it has been well known for a considerable time, it is regarded as a most dangerous species, cases being told of men dying five minutes after having been bitten; in the Malay Peninsula, however, the natives do not believe its bite to be at all dangerous. The snake, which is very inconspicuous when lying on the dead leaves amongst which it is usually found, is, unlike the American members of the genus, of a very sluggish disposition.

In *Lachesis*, of South-Eastern Asia, and Central and Southern America, the head is somewhat more elongate proportionately than in the preceding genus. The body is usually more slender and longer, and may be covered with either keeled or smooth scales. The New World species are all very venomous, while those of the Old World are not considered by the natives to be particularly dangerous.



(a)



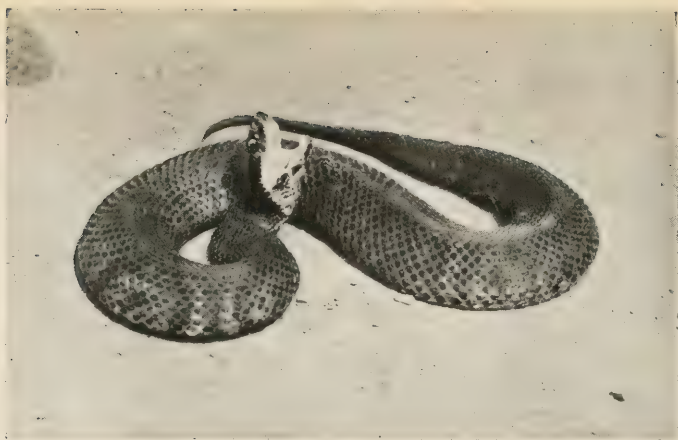
(b)



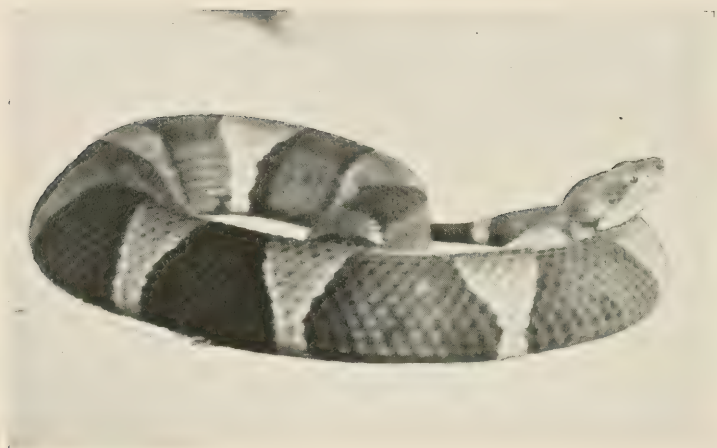
(c)

- (a) Carpet Viper, *Echis carinata*.
 (b) Cerastes Viper, *Cerastes cornuta*.
 (c) Green Tree Viper, *Atheris chlorechis*.

(a)



(b)



(c)



(a) Mocassin, *Ancistroden piscivorus*.
(b) Copper-head, *Ancistroden contortrix*.
(c) Bushmaster, *Lachesis mutus*.

L. lanceolatus, known by the name of FER-DE-LANCE in Martinique, in reference to its arrow-shaped head, and of Jararaca, in Brazil, where it grows to a length of over six feet, is the most dangerous and ferocious of the Pit-Vipers, its bite, in the island of Martinique alone, where it is very abundant in the coffee and sugar plantations, accounting annually for more than a hundred deaths. The coloration of this snake is most variable, and may be dark or light brown, grey, olive, or reddish above, with or without dark spots or cross-bars, or with dark triangles on the sides, enclosing pale rhombs; a dark streak from the eye to the angle of the mouth is constant. The Fer-de-Lance, although not so hardy as some of the representatives of the genus *Ancistrodon*, will, nevertheless, live for several years in captivity, feeding on rats, guinea-pigs, and large lizards. Like some other snakes it has a habit of vibrating the end of the tail when excited or alarmed, and thus, when resting among dry leaves, produces sounds similar to those of the Rattlesnakes.

The BUSHMASTER, *L. mutus*, of Central and Tropical America, which reaches a length of eight feet, being the largest viperine snake, is yellow or pinkish in colour on the back, with a series of large rhomboidal black spots; a black streak extends from the eye to the angle of the mouth. This handsome creature inhabits damp forest districts, where it spends much of its time in the holes of armadillos and other animals. In captivity it unfortunately does extremely badly, no specimens having been kept under artificial conditions for much more than six months, almost invariably succumbing to starvation and "casting disease." Mr. R. R. Mole, who has on

several occasions sent specimens to our Zoological Gardens, informs me that it is of the utmost importance not to handle the snake, as it has a trick of twisting itself, when held, in such a manner as to injure its vertebræ. Mr. Mole wrote to me: "One snake died in my hands in this way, and I have noticed that when handled that their backs make a cracking noise, after which they invariably die. All the snake-catchers recognize this fact, and tell stories of the snake having died on being caught."

The Bushmaster, like the Night Adder, and two other viperine snakes, *Lachesis monticola* and *Atractaspis irregularis*, is oviparous. Mr. Mole, to whom this discovery is due, says that the eggs are larger than a duck's, and are protected by the female, who coils herself round them until they are hatched.

The snakes of the genera *Crotalus* and *Sistrurus*, which inhabit America, from Southern Canada and British Columbia to Brazil and Argentina, are popularly known as RATTLESNAKES, their tails terminating in a segmented, sound-producing apparatus. The perfect "rattle" in *Crotalus* is composed of about a dozen loosely connected horny segments, which are filled with air, and which, when shaken, as is the case when these snakes are annoyed or alarmed (the reptiles rolling themselves up into a ball with the vibrating tail standing up in the centre), produce the familiar rattling sounds. The "rattle" in newly born snakes is represented by only a button-like horny covering to the tip of the tail, the subsequent segments being formed, one at a time, with each shedding of the skin. To tell the precise age of the snake by the numbers of

segments to the rattle is impossible, as the shedding process in the rattlesnakes may occur two, three, four, or even five times in the course of a year, while the terminal segments not unfrequently become detached in the course of their existence. The utility of the apparatus to the creature is somewhat problematic, but is probably of use in warning off approaching enemies, these snakes being of sluggish habits and unwilling to attack, except to secure their prey. Some believe that it serves to call the sexes together, while others suggest that the rattling sounds, which resemble running water, act as a decoy to animals in search of drink.

Rattlesnakes do not as a rule do well in captivity, for, being of a peculiarly nervous disposition, they refuse all food, and ultimately, unless forcibly fed, in which case they frequently die of shock, starve themselves to death.

In the snakes of the genus *Crotalus* the fangs are very highly developed; they inhabit dry, rocky districts, where they feed almost exclusively on mammals.

The COMMON RATTLESNAKE, *C. durissus*, of the South-Eastern United States, is the largest species, attaining a length of over eight feet. It is pale grey or light brown above, with blackish rhombs, which are edged with yellow. In spite of the fact that in many parts of its habitat this rattlesnake is very abundant indeed, being in many places the commonest species of snake, accidents from its bite are of very rare occurrence.

In *Sistrurus*, which differs from *Crotalus* in the head being covered with nine large symmetrical shields, and not with scales of irregular size, the fangs are of moderate size. The snakes of this genus, known as the PIGMY RATTLESNAKES, are all quite small, attaining a maximum length of

but two feet. The rattle is proportionately small, and can only be heard at a distance of a few feet. Although not aquatic, these snakes frequent damp or even swampy meadows, where they feed on frogs and toads; those at the gardens would also accept lizards.

Their bite, unlike in the case of the preceding genus, is not regarded as at all dangerous, the effects having been compared to the sting of a hornet.

The Pigmy Rattlesnakes, of which there are three species, inhabit North America, east of the Rocky Mountains, and Mexico.



(a)



(b)



(c)

- (a) " Rattle " of Rattlesnake.
(b) Texas Rattlesnake, *Crotalus atrox*.
(c) Pigmy Rattlesnake, *Sistrurus miliarius*, with young.

PART II
BATRACHIANS

INTRODUCTION

BATRACHIANS occupy an intermediate position in the system between Reptiles and Fish. From the former, as explained in the opening chapter on Reptiles, they differ in the skull articulating by means of two condyles, and by usually undergoing metamorphosis, breathing by gills during the first stages of their existence, and from the latter by the absence of rayed fins, as well as by the structure of the limbs, which conform to the type of Reptiles and higher Vertebrates (Pentadactyle type).

Before passing on to a more detailed account of these animals it is well to indicate the following three orders into which the class is divided. They are—

- I. The ANURA, or Tailless Batrachians (Frogs and Toads).
- II. The URODELA or Tailed Batrachians (Newts and Salamanders).
- III. The APODA or Limbless Batrachians (Cæcilians).

The skin of Batrachians is naked, except in the Apoda, which may have minute scales hidden under the skin.

In form they vary extremely, being either short, as in a Frog or Toad, more or less elongate or lizard-like, as in a Newt or Salamander, or eel-shaped or worm-like, as in a few of the Urodeles and in the Apoda. The neck is either completely absent or very much abbreviated; the head is more or less flattened; the eyes, which are usually

large, are protected by three lids, the upper, the lower, and the nictitating membrane, which moves vertically, and is of special use to the land forms when under water. In the case of some of the tailed, and one or two of the purely aquatic Tailless Batrachians, the eye is small and devoid of lids, while in cave-dwelling Urodeles, *Proteus*, *Typhlomolge*, and *Typhlotriton*, the eye is rudimentary or quite invisible superficially. The pupil, which is more or less contractile, is round or horizontal in the Urodeles, and

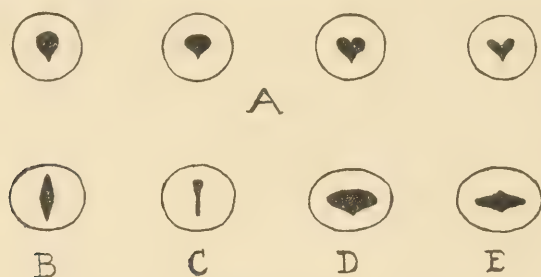


FIG. 10.—Different forms of pupils.

a. *Bombinator pachypus*.

b. *Alytes obstetricans*.

c. *Pelobates fuscus*.

d. *Rana arvalis*.

e. *Bufo vulgaris*.

(After Boulenger.)

round, triangular, horizontal, or vertical in the Anures, when contracted, such as depicted on fig. 10. The ear is rudimentary in the Apoda, the Urodela, and in a few of the Anura; in the majority of the latter it is represented externally by a circular membrane, the *tympanum*, or eardrum, which is situated behind the eye. The mouth is usually large and cleft to beyond the eyes; the upper or lower jaw, or both, as the case may be, are armed with numerous closely set, sharply pointed teeth, or teeth are entirely absent; the palate is always pierced by a

pair of orifices, the *choanæ*, or inner openings of the nostrils; there is also in most Anura a pair of inner ear-openings (*Eustachian tubes*). The tongue, which is absent in a few of the tailless batrachians, may be more or less completely adherent to the floor of the mouth, or fixed only in front, or so constructed as to be protensible to a very considerable distance, as in Chameleons. The tail of the Urodeles is cylindrical in the land forms, more or less compressed in those living in the water; in the European newts of the group known as *Euproctus*, the organ is prehensile. In the Anura the tail is absent; in the Apoda it is also absent or extremely short. The fore and hind limbs in the Urodeles are usually of nearly equal length, while in the Anura the latter are usually much the longer, and adapted for leaping; they are provided with four fingers and five toes in most forms, although the digits may, as in some Urodeles, be reduced to two only. The fingers are usually free, while the toes are often provided with an extensive web. In some Frogs both hand and foot are webbed to such an extent that, as in the arboreal Bornean species of *Rhacophorus*, they have been reported to serve as a parachute to the creature when it leaps from branch to branch. Arboreal species have the tips of the digits more or less strongly dilated, and by means of these discs they are able to attach themselves to smooth surfaces, as in the Geckos. The discs do not act as suckers, as is generally believed, but adhere by the intense pressure of certain muscles, supplemented by a sticky secretion. The adhesion is not usually effected entirely by the feet, but to some extent by the suction action of the belly, which is developed to a certain extent

in all young Batrachians. Strong, horny tubercles are frequently present, especially in the case of the burrowing Anura, on the base of the inner toe. Besides four fingers, a rudiment of thumb is almost constant in the Tailless Batrachians. In the male of some frogs, such as *Rana holsti* and *Hyla maxima*, what at first sight appears to be an innocent rudiment of the thumb, is in reality a very formidable weapon, for mounted upon the carpus is a long, sharply pointed bone, which pierces the skin when pressure is made upon it, and when one of these frogs is caught it invariably strives to insert the spurs into the hand that holds it. Some Tree-Frogs (*Hyla*) are similarly remarkable for possessing spine-like processes on the front of the arms, and the inner fingers and the breast of some South American *Leptodactylus* are armed, during the breeding season, with very powerful horny spines.

The skin of all Batrachians is studded with glands, which, in most toads, form large warts on the body, and are aggregated on each side of the head, behind the eyes, to form a large glandular mass, known as the parotoid gland. These secrete a milky, poisonous fluid, which is exuded when the animal is molested, sometimes to a considerable distance, and which serves as a protection against most mammals. Many snakes feed on both frogs and toads, not having, with a few exceptions, any repulsion for the poison. Even species with a perfectly smooth skin may be highly poisonous, the skin of our European Tree Frog, *Hyla arborea*, for example, being endowed with great toxic properties. The secretion of the frog *Dendrobates tinctorius* is employed by the Indians of Colombia for poisoning their arrows, the poison being obtained by ex-

posing the animal to fire ; from a single specimen sufficient venom is collected for the poisoning of about fifty arrows.

Although Batrachians, as well as Reptiles, differ from Mammals and Birds in the absence of hairs or feathers, hair-like appendages on the body and thighs are present in profusion in the recently discovered frog *Trichobatrachus*,



FIG 11.—The Hairy Frog (*Trichobatrachus robustus*).

(After Boulenger.)

of Africa. Sense-organs, similar to what is known as the lateral line in Fishes, are present on the sides of the head and along the body in many of the Urodeles, in all tadpoles, and in the aquatic frog *Xenopus*. As in Reptiles, Batrachians frequently change their “skin,” the thin, transparent outer layer of the epidermis, which first becomes detached at the angle of the mouth, being turned

inside out in the process. On account of the great absorbing powers of the skin, which is more or less comparable to a sponge, most Batrachians frequent damp localities ; in the few cases in which they inhabit dry, arid districts they spend the greater part of their existence underground, emerging only at night, or during the rainy season. The majority of Batrachians are born in water, in which they spend their infancy in a larval, fish-like state, breathing by gills. Although some will breed several times in a year, the greater number, especially those inhabiting temperate regions, do so only once, the time of reproduction varying considerably according to the different species. Take, for example, the three British species of the Anura ; the Common Frog, *Rana temporaria*, breeds towards the end of February or the beginning of March, the Common Toad, *Bufo vulgaris*, at the end of March or the beginning of April, and the Natterjack Toad, *Bufo calamita*, from the end of April to the beginning of July.

In many cases the males precede the females to the water, while in others the female is secured on the journey to the pond resorted to for breeding. The males of many tailed Batrachians, most newts, for instance, are distinguished, during the breeding season, by ornamental appendages, such as crests, or by more vivid colours. The eggs, which are spherical bodies surrounded by a transparent gelatinous envelope, are either laid singly, each fixed to submerged bodies, or in strings or bands, in which case they are twined round plants ; or they may form large masses, which, in a few, such as those of the Common Frog, *Rana temporaria*, float on the surface.

The amount of protection which the gelatinous envelope

affords the embryo varies considerably, as in some cases they partly dissolve in order to release the young tadpoles before the latter are able to make any movement, whilst in others a considerable amount of wriggling on the part of the embryo is necessitated to ensure its release. The size of the egg or of the larva stands in no relation to that of the parent. The number of eggs laid varies also considerably, *Bufo viridis*, for instance, laying up to 12,000, while a brood of *Alytes* may contain only twenty. The following is a list of most of the European Frogs, giving approximately the maximum number of the eggs deposited by each species—

Bufo viridis about 11,000, *Rana esculenta* about 10,000, *Bufo vulgaris* about 6,000, *Bufo calamita* about 3,500, *Rana temporaria* about 3,000, *Pelobates fuscus* about 2,000, *Rana arvalis* about 2,000, *Pelodytes punctatus* about 1,500, *Rana agilis* about 1,000, *Hyla arborea* about 900, *Bombinator pachypus* about 300, *Alytes obstetricans* about 200.

In most newts, and in many frogs and toads, a period of at least a fortnight elapses before the young emerge; in *Discoglossus pictus*, however, thirty hours suffice.

On emerging from the egg the embryo has a very large head and body. In a frog the external gills and the long, compressed tail are only feebly developed when the tadpole is just hatched, while the mouth is provided with a much developed adhesive apparatus, by means of which the young attach themselves to plants or other objects. The “holder” appears as a crescentic groove very early, before, in fact, any other organ has formed, and disappears, after having undergone various changes, in the first stages of the tadpole period; its fullest development coincides with

that of the external gills. A few days after hatching the tail elongates and becomes bordered above and below with a membranous crest; the external gills, two or three in number on each side, become branched, and the mouth acquires fleshy lips, a parrot-like beak, and horny teeth.

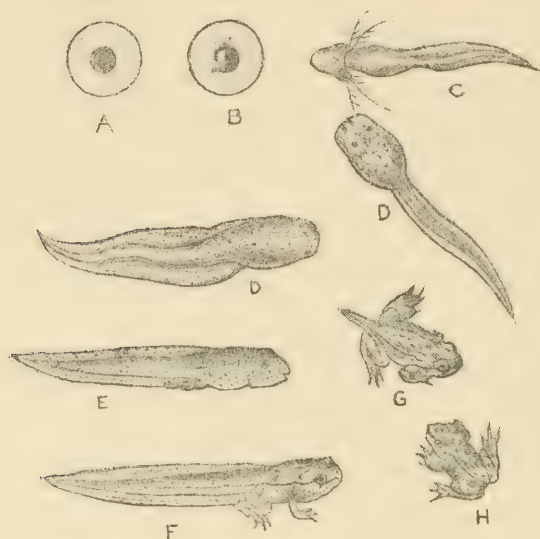


FIG. 12.—Metamorphosis of the Common Frog.

- | | |
|--------------------------|-----------------------------------|
| a. The newly laid egg. | b. On the fifth day. |
| c. On hatching. | d. After loss of external gills. |
| e. Hind-limbs growing. | f. Just before leaving the water. |
| g. On leaving the water. | h. Frog in the perfect condition. |

The external gills then disappear, and are replaced by internal gills, inserted on the gill arches, which persist until the final transformation; the water which has passed through the gills is expelled by a tube-like opening on the left side, called the *spiraculum*. The limbs then develop; both pairs grow simultaneously, although, from the fact that the fore limbs remain concealed under the skin, they

make their appearance externally long after the hinder ones ; they grow rapidly, the fingers and toes soon budding out. In the final stages of the metamorphosis the tail begins to shrink, the tissues becoming absorbed and afford food to build up the various organs of the body ; the gill arches disappear, and the lungs, which had co-existed as accessory respiratory organs, assume alone the respirating functions ; the lips are likewise absorbed, the beak is shed, and the cleft of the mouth extends ; the eyes acquire movable lids ; the extremely long intestine, due to the fact that vegetable matter forms the principal article of food during the tadpole stage, shortens. In fact, the entire body changes in form, the creature, on leaving the water, appearing, but for the presence of a short, stumpy tail, as a perfect frog.

In the newts the transformation is much more gradual, without the intercalation of a tadpole stage. The tail and the external gills are well developed when the young leaves the egg, and the fore-limbs appear some time before the hind pair. Horny teeth are never present, and the intestine does not assume the extraordinary development which is characteristic of a tadpole. The final transformation in the Urodeles consists essentially in the loss of the gills and in the development of the eyelids. I may mention that, although the larvæ of Urodeles are often called tadpoles, the term, as applied to them, is quite misleading, the larvæ of Frogs having an altogether different form and organization.

Some Batrachians have a tendency to prolong the larval life, and in the case of many Urodeles are even able to breed in that condition. A few members of this class are

born in an advanced larval condition, while a few never go near water, even for breeding purposes, the young leaving the egg or uterus in the perfect form.

Sexual maturity is reached in most Batrachians in the third or fourth year of their existence. Most Tailless Batrachians, during the breeding season, are notorious for the loud sounds which the males produce by means of their vocal sacs, and to which the female responds by mere grunts; although vocal sacs are absent in all Urodeles, they are not absolutely dumb, producing at times more or less distinct squeaks.

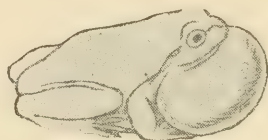


FIG. 13.—European Tree-Frog, *Hyla arborea*, showing inflated vocal sac.

(After Boulenger.)

The vocal sac, characteristic of the males of many Tailless Batrachians, frequently forms one or two bladder-like pouches, into which the air penetrates by one or two small openings or slits in the floor of the mouth. The pouch, when the animal croaks, becomes blown out to a very considerable extent, and may, as in the European Tree Frog, attain almost as large a size as the creature's body. The voice of Frogs and Toads varies very considerably, and affords the collector a means of ascertaining the whereabouts of the different species.

The power of regenerating lost parts is possessed by the Urodeles and the tadpoles of the Anures. Newts are able, throughout life, to regenerate both the tail and

the limbs, as well as other parts, while in tadpoles, although the tail and rudiments of hind limbs, if cut off, immediately grow again, will only do so in the early stages, the power decreasing rapidly with age.

The food of Batrachians is exclusively animal, except in the larval stages. They cannot drink, but absorb the necessary water through the skin. According to Donaldson, some frogs, after being kept in dry air for a few hours, lose about fifteen per cent. of their weight, which is regained, when replaced in water, in under twenty-four hours.

Batrachians cannot stand extreme heat; to cold they are not very sensitive, and species of temperate climes do not show any very evident signs of distress under ice.

The name *Amphibians* is frequently used to designate this class of animals; if we adopt that of Batrachians it is in consideration of the fact that the former term has for a long time in the past been used as a common designation for both Reptiles and Batrachians, for instance, by Linnæus; when the Amphibians were first divided into two classes, the name *Reptilia* was given to the higher class, that of *Batrachia* to the lower.

CHAPTER I

THE ANURA—TAILLESS BATRACHIANS

THIS order, containing nearly 1,200 species, is divided up into two sub-orders: (1) the tongued *Phaneroglossa*, and (2) the tongueless *Aglossa*. The former is further divided into two series according to the structure of the shoulder girdle, the two halves not being united, but overlapping in (a) the *Arcifera*, while in (b), the *Firmisternia*, they are united by cartilage, forming a firm median bridge. The transverse processes of the sacral vertebra (usually the ninth, which suspends the hip-girdle) may be either perfectly cylindrical or very much dilated, and this character, in conjunction with the presence or absence of teeth in the jaws, is made great use of in the classification of the *Anura*.

Sub-order PHANEROGLOSSA :—Series I—FIRMISTERNIA.

In the family *Ranidæ*, the true frogs, which are distributed throughout the world, with the exception of the southernmost parts of South America, nearly the whole of Australia, and New Zealand, the upper jaw is toothed, and the transverse processes of the sacral vertebræ are not dilated.

In the type genus *Rana*, represented by over one hundred and fifty species, the tongue is deeply notched and free

behind; the fingers are free, the toes, with simple or dilated tips, are more or less webbed. The pupil is horizontal. The tympanum may be large and very distinct, or entirely hidden.

The COMMON FROG, *R. temporaria*, inhabits the whole

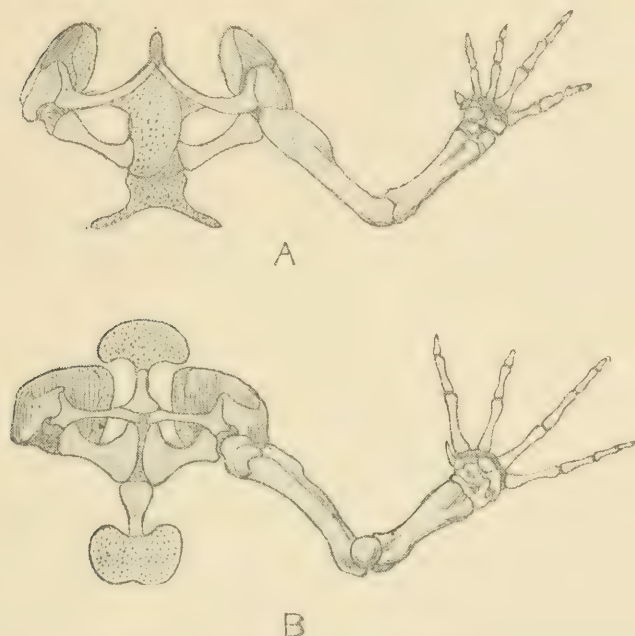


FIG. 14.—Pectoral Arch and Fore-limb of (A) *Discoglossus pictus*, showing Arciferous type, and (B) *Rana esculenta*, showing Firmisternian type.

(After Boulenger.)

of Northern and Central Europe, and extends across Northern Asia to Eastern Siberia and Northern Japan. The snout is rounded and only slightly projecting beyond the mouth. The skin is perfectly smooth, or with only a few irregular, smooth warts, and with a dorso-lateral glandular fold. Males differ from females in the greater development of the web between the toes, which is almost

complete during the breeding season, in the presence of a pair of internal vocal sacs, situated at the sides of the throat, and by the presence of a pair of swollen pads on the inner fingers, which, during the breeding season, are covered with numerous black, horny spinules.

The coloration varies enormously, no two specimens being alike; the ground colour, which may be grey, brown, yellow, or red, is spotted or marbled with darker; the limbs are usually transversely banded.

Although a terrestrial frog, spending most of its life in fields and meadows, the Common Frog is not unfrequently found in ponds throughout the summer, while many, especially males, hibernate under water. The breeding season falls in January and February in Central Europe, usually in March in the North. The recurrence of cold weather after the frogs have begun to spawn may cause them to return to their winter quarters, with the result that the breeding season may be broken up into two or three periods within a couple of months. The Common Frog exercises no discrimination in the choice of the locality in which it lays its eggs, and will spawn in large ponds, slow-running brooks, or even in puddles, which are certain to dry up before the tadpoles have completed their metamorphosis.

The eggs, which vary in number from 1,500 to 4,000, according to the size of the female, are perfectly round, and form large clumps which float on the surface of the water. The young are released two or three weeks after the eggs have been laid, and are able to leave the water in May or June, later in the extreme north or high up in the mountains. In Scotland tadpoles are often still found in August, and are even sometimes compelled to hibernate.



Common Frogs, *Rana temporaria*.



Edible Frog, *Rana esculenta*.



American Bull Frog, *Rana catesbeiana*.

The EDIBLE FROG, *R. esculenta*, has also a very wide distribution, occurring throughout the greater part of Europe, Western Asia, and North-West Africa. In England it used to be common in Cambridgeshire, and at the present day it still exists in fairly large numbers in certain parts of Norfolk. As the British specimens agree with a variety common in Italy, the frog is, perhaps, not

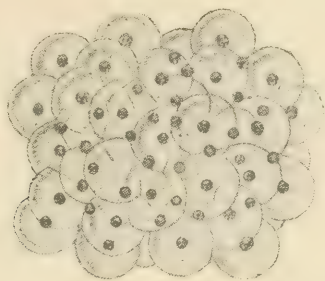


FIG. 15.—Eggs of Common Frog.

(After Boulenger.)

indigenous in this country, and it has been suggested that it may have been originally introduced by the monks.

The snout in this frog is obtusely pointed and projecting considerably beyond the mouth; the tympanum is one-half to three-fourths the diameter of the eye. The toes are fully webbed. The skin is smooth, but for a few small granules on the sides and on the hind limbs; a lateral glandular fold is constant. The upper parts are usually green, but sometimes brown, olive, uniform or spotted with dark olive or black, and sometimes with a light yellow, green, or blue vertebral stripe; the hind limbs are usually barred with darker. Blue specimens are occasionally found, but are rare, and are mere individual abnormalities due to the absence of yellow pigment.

There is no such thing as green or blue pigments in batrachians, green being produced by a mixture of black and yellow, blue by the absence of the yellow, the black pigment combining with certain white cells to form the blue colour. *R. esculenta* presents a very great amount of variation, not only in colour, but also in structure, the length of the limbs and the size and shape of the rudimentary sixth toe, for instance, differing to such an extent as to warrant specific distinction in the eyes of some zoologists.

The Edible Frog is essentially aquatic, keeping to ponds, slow-running rivers, or ditches, or to their banks, and is, in fact, very seldom found at any distance from water. The male, which is provided with two highly inflatable external vocal sacs, one on each side of the head, behind the angle of the mouth, croaks not only during the breeding season, but throughout the summer months. The eggs, 5,000 to 10,000 in number, are similar in shape, but smaller than those of the Common Frog, and are laid in April and May in the south, in June in the north. Unlike those of the common species, they do not float on the surface, but sink to the bottom of the pond. The embryo leaves the egg with external gills and a well-developed tail, and the tadpole transforms in the late summer.

As its name implies, this frog is eaten in many parts of Europe, the flesh of its hindquarters being esteemed as a delicacy, and in France, Switzerland, and Italy many people earn a living by frog fishing. According to a recent report in the *Bulletin de la Société Nationale d'Acclimatation*, of Paris, the Common Frog is just as frequently brought to market, and just as much appreciated as the Edible Frog. In the price lists of the Paris markets, frogs appear under two categories—*grenouilles de pêche* and

grenouilles de parc, the latter being considered much the superior, owing to their larger size; they are received from the Department of Vendée, where immense marshes have been drained, and parallel ditches, miles long, have been dug. The sale of frogs in Paris is said to amount to about 80,000 francs per annum.

The AGILE FROG, *R. agilis*, a close ally of *R. temporaria*, which inhabits Southern Sweden, Denmark, Jersey, the greater part of France, Italy, a few localities in Germany, Austria, and South-Eastern Europe, is remarkable for the great length of its hind limbs, which enable it to take leaps of quite six feet. The snout, which is long and obtusely pointed, projects but slightly beyond the mouth. The tympanum is very large, almost equalling the eye in size. The toes are about two-thirds webbed. The skin is usually perfectly smooth, sometimes with a few flat glands and dorso-lateral glandular folds. The upper parts vary in colour from yellowish or pinkish to grey or dark brown, uniform or spotted with blackish; a Λ -shaped, dark marking is usually present between the shoulders. The colour often suggests the dry leaves under which the frog may seek refuge when pursued.

The Agile Frog is usually found in woods and meadows, never in fields or gardens, and goes to the water only during the breeding season, which extends from the end of February to the middle of April. The eggs, which resemble, both in size and shape, those of the Common Frog, are found attached to submerged plants on the borders of small ponds. The tadpole finishes its metamorphosis towards the end of June or July.

The BULL FROG, *R. catesbiana*, which is distributed over the greater part of Eastern North America, is the largest

of the American frogs, measuring up to eight inches in length. The body is very stout. The snout is rounded, and not projecting beyond the border of the mouth. The tympanum is extremely large, especially in males, equalling or exceeding the eye in size. The toes are completely webbed. The skin is perfectly smooth. The colour of the upper parts vary from olive to dark brown, with or without dark spots; the arms and legs are usually barred.

Bull Frogs, which have derived their name from their croak, which bears some resemblance to the distant roar of a bull, do not awake from hibernation until the end of May or the beginning of June, when they collect together in numbers in large ponds. The tadpoles, which are remarkable for their size, measuring as much as seven inches in length, do not turn into frogs until the second or sometimes even the third year. Like the European Edible Frog, the Bull Frog seldom leaves the water, where it feeds on all sorts of animals. Captive specimens may be given worms, small birds, and mice. The Bull Frog is much esteemed as an article of food, and "Bull Frog" raising is a most profitable industry in several of the States. Hunting for this species is, unfortunately, in consequence carried on to such an extent that its extinction is threatened in some parts of its habitat.

The TIGRINE FROG, or INDIAN BULL FROG, *R. tigrina*, of India, Ceylon, the Malay Peninsula, and Southern China, does not attain quite so large a size as the preceding species, and specimens of over six inches in length may be considered giants. From the American Bull Frog it may be easily distinguished by its pointed and projecting snout, and by the skin of the back being covered with numerous

long, glandular folds ; the tympanum is smaller, measuring about two-thirds the size of the eye, while the toes are not quite so fully webbed. The upper parts are grey, brown, or olive, with large dark streaks or spots. The tadpoles attain a maximum length of five inches.

THE SPECKLED FROG, OR AFRICAN BULL FROG, *R. adspersa*, of South and East Africa, which attains just as large a size as the American Bull Frog, in its heavy form and rather short limbs, somewhat resembles a toad ; it agrees with *R. catesbiana* in its rounded snout, and with *R. tigrina* in the skin of the back being covered with numerous longitudinal glandular folds. The tympanum is not quite as large as the eye. The colour above is usually olive, often with a light vertebral line. This frog is provided with a large shovel-like tubercle, which is situated on the inner side of the foot, which enables it to burrow, and captive specimens may remain underground for months on end, only appearing above ground when hungry.

THE GOPHER FROG, *R. capito*, of Florida, a moderate-sized species, is also stout and toad-like in appearance, having a very large head, prominent eyes, and an enormous mouth. The very stout body is covered with numerous elongate warts. The colour varies in the same individual from a very pale grey, with large dark spots, to a uniform dark brown. Except during the breeding season, when it frequents small ponds, the Gopher Frog lives in the burrows of the tortoise, *Testudo polyphemus*. Miss Dickerson states that the frog sits at the mouth of the burrow watching for prey, and that it disappears with such rapidity at the approach of danger that, not only is it seldom seen, but, to be captured, has to be dug out of the burrow. It feeds principally on toads.

The GIANT FROG, *Rana goliath*, of Cameroon, the largest of all tailless batrachians, attains a length of nearly a foot. This frog was discovered only quite recently by a former keeper in the London Zoological Gardens, who endeavoured to bring one home alive. The frog was put into an empty ten-gallon spirit drum with water at the bottom, but, unfortunately, on the second night after its capture it succeeded in raising the heavy cover of the drum, a feat requiring enormous strength, and in escaping. A second specimen, however, was procured, and is preserved in the Natural History Museum.

R. opisthodon, of the Solomon Islands, a species attaining a maximum length of five inches, is remarkable for the fact that its entire metamorphosis is undergone within the egg. The eggs, which are perfectly round, are deposited in the crevices of rocks, close to running water. The following notes were made by Mr. Guppy, their discoverer: "Each of these balls contained a young frog, about four inches in length, apparently fully developed, with very long hind legs, and short fore legs. On my rupturing an egg in which the little animal was doubled up, the tiny frog took a marvellous leap into its existence, and disappeared before I could catch it. On reaching the ship an hour after I found that some of the eggs which I had put in a tin had been ruptured on the way by the jolting, and the liberated frogs were leaping about with great activity. On placing some of them in an open-mouthed bottle, eight inches long, I had to put the cover on, as they kept leaping out."

R. cyanophryctis, a thoroughly aquatic frog, inhabiting India, has the curious habit of making leaps over the

surface of the water, alighting on all fours and starting again, as it would on land.

Arthroleptis, a genus of small, slender frogs restricted to Africa, is made up of about a dozen species. The limbs are comparatively long, with the fingers and toes almost free. The pupil is horizontal. The tympanum may be distinct or hidden.

A. seychellensis has peculiar nursing habits, the male or female, it is not known which, carrying the tadpoles, to the number of about a dozen, which are provided with long tails, about on the back, the larvæ clinging on by their bellies. Whether the young undergo the whole of their metamorphosis on their parent's back, or whether they are taken to the water to complete it, has not been ascertained.

Hylambates, an arboreal genus, inhabiting Tropical Africa, has the tips of the fingers and toes, both of which are more or less webbed, dilated into discs. The pupil is erect.

In *H. breviceps*, of the Cameroons, the female protects its eggs, which are large and few in number, by carrying them about in the mouth.

Rhacophorus, another arboreal genus, is composed of nearly fifty species, which inhabit the East Indies, China, Japan, and Madagascar. Both fingers and toes are webbed; the extent of the web differs much, the fingers in some species being completely webbed, whilst in others they are not even half-webbed. As in true tree-frogs, the tips of the fingers and toes are dilated into large round, adhesive discs. The tympanum is generally distinct. The pupil is horizontal. The tongue is free and deeply notched. In the majority of species the coloration harmonizes with

the surroundings, some being green, others olive, olive-brown, or grey in colour.

The "FLYING" FROG, *R. nigropalmatus*, which inhabits Borneo, has both hands and feet entirely webbed, these being said to be used by the creature as parachutes, the frog having been observed to come down to the ground, as if flying, from great heights.

R. schlegelii, of Japan, which has the fingers only about half webbed, is of particular interest on account of its remarkable breeding habits. The male and female construct underground chambers in the damp earth on the edge of flooded rice fields, about a foot above the surface of the water. On the completion of the operation the female produces a secretion from the vent which she beats up with her feet, thus forming a frothy mass, and in which the eggs are deposited. Both male and female then leave the burrow, not, however, as one would suppose, by the way they came in, but by an obliquely directed tunnel leading to the water, which they have previously excavated, and by means of which the tadpoles, when they hatch, find their way out.

R. malabarius, of India, and *R. reticulatus*, of Ceylon, have likewise peculiar breeding habits. In the former the eggs are deposited in nests of froth attached to leaves overhanging the water in which the larvæ, when at a sufficiently advanced stage, fall, while in the latter they are carried about by the female attached to her belly, to which they adhere.

The family DENDROBATIDÆ, which is represented by three genera, one in South America, one in West Africa, and one in Madagascar, is separated from the previous one,

with which it otherwise agrees, by the entire absence of teeth.

Dendrobates, of Tropical America, is an arboreal genus made up of seven species, all of which are of small size. The pupil is horizontal. The tympanum is more or less distinct. The fingers and toes, the tips of which are dilated into round, adhesive discs, are free.

D. trivittatus, of Brazil and Peru, spawns in shallow puddles in which the water evaporates within a few days. When the water dries up, the father, who keeps a strict watch over his offspring, transports the tadpoles to other pools, the latter adhering to their parent's back by means of their sucker-like lips. In this manner they are conveyed from one pool to another, until the entire metamorphosis has been completed.

D. tinctorius secretes a very active poison, which is used, not only as mentioned in the Introduction, for the poisoning of arrows, but also, it has been stated, for dyeing green Amazon parrots, some of the green feathers of the latter being plucked out and the bare places rubbed with the living frog, with the result that the new feathers appear as yellow instead of green.

The family ENGYSTOMATIDÆ is composed of a large number of mostly narrow-mouthed, ant-eating frogs or toads; it includes terrestrial, aquatic, and burrowing types; the latter have either the hind pair of limbs or the front pair much strengthened, and provided with large horny sheaths. The jaws are toothless. The transverse processes of the sacral vertebra are dilated.

Rhinoderma, represented by a single species, *R. darwini*, a small frog discovered by Darwin on his voyage in the

Beagle, is characterized by a long and triangular snout, ending in a fleshy lobe. The pupil is horizontal. The tympanum is hidden. The fingers and toes, the tips of which are not dilated, are incompletely webbed. The skin is smooth. The manner in which this frog takes care of its offspring is most extraordinary, the eggs being nursed by the male, who retains them in its vocal sac, the latter extending over almost the entire ventral surface. The larvæ do not develop gills, and the tail, which is at no part of its development very large, disappears before the young leave the pouch.

Phryniscus, of Tropical America, a genus in which the snout is only feebly elongate, is represented by numerous species. The pupil is horizontal. The tympanum is hidden. The fingers are provided with a mere rudiment of a web, while the toes vary much in the extent of the webbing.

The SOUTH AMERICAN DWARF TOAD, *P. nigricans*, is a minute creature, attaining a length of barely an inch. The upper parts, which are covered with small warts, are uniform black, or black with a few light yellow spots; the under-surfaces are black, with large crimson and yellow or orange markings. According to Budgett, both sexes utter a call note during the breeding season which consists of two clear, musical "rings," followed by a long, descending "trill," very much like that of our Greenfinch. The eggs, which are laid separately, are deposited in temporary pools, and are washed down by heavy rains to deeper waters. The development is remarkably rapid, a number of eggs, the segmentation of which began at 10 a.m., hatching at 7 a.m. the following morning.

A number of specimens which are living, at the time of

writing, in Regent's Park, refuse flies and spiders, and feed exclusively on ants, of which they consume large quantities. These curious little toads do not hop, but run about with considerable rapidity, and thus, when on the move and half hidden by the vegetation in their cage, resemble beetles rather than frogs or toads. On arrival these specimens, when disturbed, would turn over and lie on their backs, exhibiting the bright warning colours of their under-surfaces.

Breviceps, of Africa, are curious little burrowing creatures, with globular bodies and very short, stout legs, provided with large shovel-shaped tubercles for digging purposes. The snout is very short and the face scarcely projects at all beyond the rotund outline of the body. The mouth is very narrow. The pupil is horizontal. The fingers and toes are both quite free.

Hemisus has a pointed snout, very small eyes, and digs with the hands only, which are modified accordingly. It does not go to the water for oviposition, the mother sitting on the eggs, in which the young undergo the greater part of their metamorphosis, emerging as tadpoles in an advanced condition. The breeding habits of *Breviceps* are still unknown, no observations having been made upon them. The toads of the above two genera feed entirely on ants; they emit loud and shrill squeaks when alarmed or suddenly handled.

The frogs of the family CYSTIGNATHIDÆ, of America and Australia, as well as those of the families to follow, belong to the series ARCIFERA, in which the two halves of the shoulder girdle overlap on the median line. The upper jaw is toothed. The transverse processes of the sacral

vertebra are not dilated. Arboreal, aquatic, terrestrial, and burrowing forms are all represented.

The most interesting members of the family are those belonging to the genus *Ceratophrys*, burrowing toads inhabiting the greater part of South America. The upper eyelid of these creatures is frequently produced into a horn-like appendage. Some species have a bony dorsal shield hidden under the skin, and quite free from the underlying vertebræ, whilst in a little toad of the family *Engystomatidæ*, *Brachycephalus ephippium*, in which a similar bony shield is present, it is fused with the vertebral column. The head is very large; the pupil is horizontal. The tympanum is distinct in some species, hidden in others. The fingers are free, and the toes more or less webbed; the tips are not dilated.

THE ORNAMENTED CERATOPHRYS, *C. ornata*, of Southern Brazil and the Argentine, is the most beautiful of the ten species, and well deserves its specific name. The upper surfaces, which are very tubercular, are bright green, with large reddish-brown, black-edged markings; the jaws are of a bright yellow. The upper eyelid is raised and pointed, and triangular in shape, without forming a regular horn. The lower surface of the foot is, as in most burrowing toads, equipped with large shovel-shaped, bony tubercles, which are covered with a horny sheath, with cutting edge.

This toad spends the greater part of its existence below the surface, or half underground, the upper parts being sometimes merely sprinkled with loose earth which the animal manages to throw upon its back with its feet, being thus practically invisible. When excited or alarmed it will utter startling cries, not unlike those of an infant, and will at the same time open its mouth widely in a very



(a)



(b)



(c)

- (a) Indian Bull Frog, *Rana tigrina*.
(b) African Bull Frog, *Rana adspersa*.
(c) Gopher Frog, *Rana capito*.

(a)



(b)



(c)



- (a) Darwin's Frog, *Rhinoderma darwini*.
(b) Argentine Dwarf Toad, *Phrynosoma nigricans*.
(c) South African Burrowing Toad, *Breviceps gibbosus*.

hostile attitude, screaming loudly all the while. When in this fit of anger the lungs are much inflated, and the body, which is raised above the ground, becomes swollen like a balloon. The Ornamented Ceratophrys will feed on worms, other frogs, and mice; that it is capable of undergoing long periods of starvation was recently demonstrated by a specimen belonging to Mr. Albert Pam, which, in spite of the fact that it was not fed at all during the absence of its owner, a period of over nine months, was in perfect condition on his return.

In the HORNED CERATOPHRYS, *C. cornuta*, which inhabits Northern Brazil, the upper eyelids are produced into very large horn-like appendages. The head is enormous and much elevated. In colour it is orange and brown above, with dark symmetrical markings.

Some of the frogs of the genus *Leptodactylus*, of Tropical America, which much resemble true frogs in their appearance, have exceedingly interesting breeding habits. The pupil is horizontal. The tympanum is usually large and always distinct. The fingers and toes are free, not, or but slightly, dilated at the tips.

L. ocellatus lays its eggs in a small puddle which it produces by building a wall of mud on the edge of a pond, and in which the tadpoles remain imprisoned until the rainy season, when the walls fall in and they are liberated.

Some other members of the genus lay their eggs in foamy masses, under leaves, close to the banks of the ponds, into which they are washed during the period of heavy rains.

Hylodes is a large genus of small arboreal frogs, also of Tropical America. The fingers and toes are free, or almost free, with dilated tips.

H. martinicensis, of the West Indies, which is light yellow in colour, with dark brown markings, undergoes the whole of its development within the egg. This frog, some fifteen years ago, was unintentionally introduced into the hot-houses at Kew, where it has maintained itself to the present day. The following is an extract from a letter on the subject, by Dr. Günther, which appeared in *Nature*: "A short time ago I was informed by Mr. W. Watson, the Assistant Curator, that in some of the hot-houses specimens of a small frog had been noticed, which, hiding away during the day among the pots and orchid baskets, enlivened the quiet evenings with their shrill, whistling notes. Suspecting that this frog must be a foreign importation, I asked the Director to allow some of the specimens to be caught, and some days later I had the pleasure of receiving three specimens in excellent condition. Mr. Watson recollects that he observed it first some ten years ago, that he lost sight of it for some time, but that it reappeared about four or five years ago. Taking into consideration the few facts with which we are acquainted as to the reproduction of this frog, it seems most probable that several specimens of both sexes were, on more than one occasion, accidentally introduced. However that may be, it is evident that the frogs have freely propagated since their introduction. At present they are most numerous in the propagating houses, in which the temperature ranges between 80° and 100° , sinking in winter to nearly 60° . Accompanying Mr. Watson one evening, I heard from several points the call of the frogs, which somewhat resembled the piping of a nestling bird; and, guided by the sound, I had soon the pleasure of seeing one of them clinging to the side of a glass case. There is

nothing extraordinary in the accidental importation of individuals of a tropical species of frog into Europe ; but it is an interesting experience that the species should have permanently established itself. This is owing, in the first place, to the favourable conditions under which it found itself placed, and, secondly, to the peculiar mode of its reproduction."

The eggs, which number about twenty, are deposited on leaves, and the frogs hatch out after a fortnight.

In *Chiroleptes*, of Australia, a burrowing genus, the first finger is opposite to the others. The fingers are free, the toes webbed, with the tips not dilated.

C. platycephalus is known to the natives as the "Water-holding Frog," on account of the large amount of water stored up in the body cavity, giving the creature a much swollen appearance. Prof. Baldwin Spencer has come across this species in Central Australia, where the natives collect large numbers of these frogs, especially in the very hot weather, thus securing water for drinking purposes, as much as a wineglassful of liquid being contained in a single specimen. He says that they seem to prefer hard clay rather than sand for digging in, as the sand beds are evidently too loose for the formation of the burrow. The frogs are found about a foot underground, in the hard-baked clay, puffed out into a spherical shape, just filling up a cavity, the walls of which are moist.

The eggs of this curious little creature are laid during the rainy season, in temporary puddles, which, unless a second rainfall occurs, quickly dry up, causing the death of the tadpoles. By far the greater number in consequence never attain maturity, in spite of the fact that the development is exceedingly rapid.

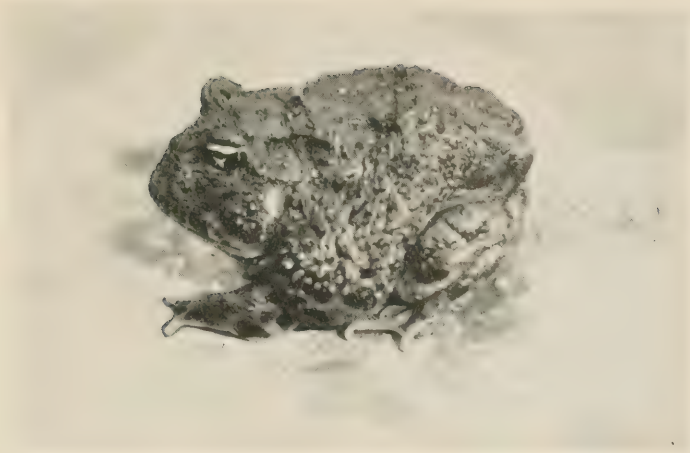
Pseudis, of South America, is composed of half a dozen species, some of which have the tips of the fingers pointed, while others have them swollen into small discs. The pupil is horizontal. The tympanum is distinct. The fingers are free, the toes extensively webbed.

P. paradoxa, which in the adult does not attain a larger size than our Common Frog, is remarkable for the fact that its tadpole grows to a record size, much exceeding, both in length and in bulk, the adult form. In consequence of its enormous size, the tadpole was described by the old writers as an animal which began life as a frog, but which eventually turned into a fish.

The family BUFONIDÆ, which includes terrestrial, burrowing, aquatic, and even arboreal types, is divided into eight genera and about one hundred and twenty species, distributed all over the world, with the exception of Madagascar and a few islands in the Pacific. The teeth are entirely absent in both jaws; the processes of the sacral vertebra are dilated.

In the type genus *Bufo*, by far the largest of the family, the tongue is elliptical or pear-shaped, and free behind. The fingers are free and the toes more or less webbed, with the tips simple or dilated into small discs. The tympanum is usually distinct.

The COMMON TOAD, *B. vulgaris*, found all over Europe, North-West Africa, and the greater part of temperate Asia, is brown, olive, greyish, or reddish above, uniform, or with brown or black spots or marblings. In Chinese and Japanese specimens a yellow vertebral line is frequently present. The head is large, with a short and blunt snout; the tympanum is small and sometimes indistinct. The



Ornamented Ceratophrys, *Ceratophrys ornata*.



Horned Ceratophrys, *Ceratophrys cornuta*.

(a)



(b)



(c)



(a) Common Toad, *Bufo vulgaris*.

(b) Natterjack Toad, *Bufo calamita*.

(c) Green Toad, *Bufo viridis*.

toes are at least half webbed. Vocal sacs are absent. The upper surfaces are covered with prominent wrinkles and warts, the pores of which are quite distinct to the naked eye. Some specimens are remarkable for the large size of the warts, which may be very spinose. The parotoid glands, which are oval or elliptical in shape, are very highly developed, being often more than half as long as the head; the lower surfaces are granular. The male is always smaller than the female, the difference in the size of the sexes being most marked in specimens from Northern Europe.

The Common Toad is very terrestrial, living, except during the breeding season, in holes, from which it emerges towards dusk in order to search for insects and worms, which it catches, after careful aiming, by darting out its tongue. Pairing takes place in England towards the beginning of April, earlier in warmer localities, usually about three weeks later than the Common Frog. The latter batrachian, as has previously been mentioned, does not take the slightest trouble in choosing a locality for the laying of its eggs. The Common Toad, however, is most particular in its choice of suitable water to breed in, and will travel long distances and surmount all obstacles to reach a certain pond, the "rendezvous" of all the toads for miles round, in spite of the fact that on its journey it may have passed ponds which, to our minds at least, would seem eminently suitable for the purpose. Travelling to the ponds takes place by day as well as by night. Should a high-road be situated in the neighbourhood of the pond where these batrachians meet, it is not unusual to find hundreds of crushed corpses of toads, which have been run over by motor-cars and other vehicles. The

males are always the more numerous, and great fights take place for the possession of the females. As the above account shows, the instinct of orientation is very highly developed in this species. Some years ago my father made a few simple experiments on this instinct. He took a number of pairing individuals out of a pond frequented by the species, which was only a short distance from another in which frogs spawn, but to which toads never resort. The toads were turned loose on a monticule midway between the two ponds, from which neither could be seen. All, after a little hesitation, or after a few hops

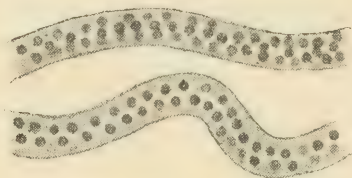


FIG. 16.—Eggs of Common Toad.

(After Boulenger.)

in the opposite direction, took the right orientation, and made their way straight towards the pond where they were taken from. Single specimens, pairs, and groups of individuals were experimented on, and all with the same result.

The eggs of this toad, which number from 4,000 to 7,000, are deposited in long strings, twisted round water plants or submerged branches; they are quite small, and form files of three or four. The tadpoles measure at the most an inch in length, which is surprising considering that this is the largest of the European batrachians; they transform about a couple of months after the eggs have been hatched.

The Common Toad is by a long way the most intelligent of all batrachians, learning in a very short time to recognize its master. It lives a long time in captivity, provided that several specimens are not kept together, as, when they congregate in numbers, they are liable to become infested all over with large sores, these ultimately causing their death. The average English toad seldom measures more than three inches in length; in Jersey and Southern Europe, however, it grows to a very large size, often attaining a length of five inches.

The GREEN TOAD, *B. viridis*, is very variable in colour; it may be greyish, greenish, yellowish, or pinkish above, with large irregular-shaped blotches, varying in colour from bright green to dark olive, and which are often margined with black; a fine yellow vertebral line is sometimes present. The head is moderately large, with a blunt snout; the tympanum is distinct. The hind limb varies much in length, and may be moderately elongate or very short; the digits are short, the toes half webbed or two-thirds webbed; a distinct fold runs along the inner side of the extreme end of the hind limbs. The back is covered with warts of various sizes, and the parotoid glands are prominent and very variable in shape.

This species, which attains a maximum length of about four inches, is widely distributed throughout Central and Southern Europe, but is absent from Western Europe; it is also found in various islands of the Mediterranean, in North Africa from Morocco to Lower Egypt, and in South-Western and Central Asia as far east as the Himalayas. In Europe it reaches an altitude of 6,500 feet, while in the Himalayas it has been observed at 15,000 feet, the highest point from which a batrachian has been recorded.

The Green Toad is somewhat more aquatic than the Common Toad, the breeding season, which begins in April, extending to June. The eggs, which are much more numerous than in the latter species, numbering up to 12,000, although somewhat smaller, greatly resemble those of *B. vulgaris*. The tadpole, however, is larger than that of either the Common Toad or the closely allied Natterjack Toad, and attains a total length of nearly two inches.

The variety *arabicus*, of Arabia and Northern Egypt, is a dwarf form, not growing to more than two inches in length. Specimens received from Captain Flower were very aquatic in their habits, spending, unlike the typical form, the greater part of their time swimming about in the water.

The NATTERJACK TOAD, *B. calamita*, is found in dry, sandy districts over the greater part of Northern and Western Europe. In the British Isles it is found in a few localities in Ireland and Scotland, while in England, although decidedly local, it is widely distributed. From the Green Toad, which in some cases it superficially resembles, it may be distinguished by the toes being merely webbed at the base instead of at least half webbed, by the shorter limbs, and by the first finger not extending beyond the second, as is the case in *B. viridis*. The snout is short and blunt; the tympanum is small and sometimes indistinct; the hind-limb is short, and only slightly longer than the head and body. The upper parts are covered with numerous large warts; the parotoid glands are small. The colour of the upper surfaces is greyish or greenish-brown, with brown and olive markings, which, however, are not so distinct as in the Green Toad; some of the

larger warts are often red ; a yellow vertebral line almost invariably extends along the middle of the back. The lower surfaces are dirty white, spotted with blackish.

Owing to its remarkably short hind limbs the Natterjack is unable to hop, but progresses by running, the body being raised from the ground. The breeding season is very prolonged, and may last from the end of April until the beginning of August. The eggs, about 4,000 in number, are laid in strings of two files, and are deposited in small ponds. In Northern Europe, where this species is very abundant in the sand-hills close to the sea, the eggs may be deposited in small, strongly brackish pools, in which the larvæ develop as rapidly as in the case of those in fresh water. The tadpole is the smallest of all European species, seldom attaining a length of more than three-quarters of an inch. The Natterjack Toad will live for a considerable time in captivity, provided it is kept dry and given opportunities for burrowing.

The AMERICAN TOAD, *B. lentiginosus*, the commonest toad of the Eastern United States, is light brown or olive above, with pale patches, and with yellow warts. In this toad, which may measure up to four inches in length, the head is rather large ; the skin is very warty, and the kidney-shaped parotoid glands are well developed. The tympanum is nearly as large as the eye.

Pairing takes place from the end of April until the beginning of July, when the eggs, up to 12,000 in number, are produced in long coils as in our Common Toad.

The OAK TOAD, *B. quercicus*, one of the smallest of toads, measuring not much more than an inch in length, is found in Carolina, Georgia, and Florida. The coloration is dark brown, with a yellow vertebral streak extending to the

middle of the back. The upper parts are thickly covered all over with minute warts. The webs of the toes are short. This toad, which is constantly being taken for the young of other species, is found most commonly in oak forests. Miss Dickerson states that after heavy rains the Oak Toads resort in large numbers to shallow pools, where, although difficult to see, they give notice of their presence by an ear-splitting chorus of high-pitched sounds, not unlike those produced by young birds. The individual call is, it appears, like that of a quite young chicken in distress, but much louder.

The GIANT TOAD, *B. marinus*, which attains a length of over half a foot, is very abundant in Southern and Central America and the West Indies. The crown of the head is covered with prominent bony ridges. The snout is short and blunt; the tympanum is small but distinct; the parotoid glands, which vary much in shape, are often enormous and much swollen, and discharge like squirts when the toad is irritated. The upper parts, which are brown, immaculate, or with large dark spots, are covered with a few irregular, sometimes spiny, warts.

The breeding period begins with the rainy season, and lasts three or four months. The transformation from the tadpole to the perfect form is rapid, and the young toads are only a quarter of an inch in length when they take to land. This species, although occasionally refusing to feed in confinement, will usually thrive in quite a small cage, and does not require any very high temperature.

The CAMEROON TOAD, *B. superciliaris*, a large toad, only slightly inferior in size to the last-mentioned species, is remarkable for having the eyelids much raised, and triangular in shape. The upper parts are vividly coloured



Cameroon Toad, *Bufo superciliaris*.

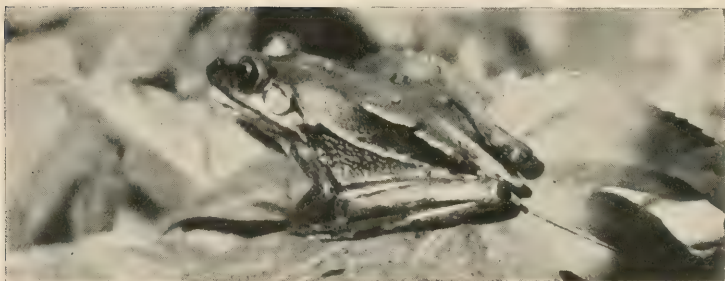


Giant Toad, *Bufo marinus*.

(a)



(b)



(c)



(a) European Tree Frog, *Hyla arborea*.

(b) Golden Tree Frog, *Hyla aurca*.

(c) White's Tree Frog, *Hyla caerulea*.

with yellow and crimson. Apart from its large parotoid glands, the skin is perfectly smooth.

The EASTERN TOAD, *B. asper*, a very abundant species in the Malay Peninsula and Archipelago, grows to almost as large a size as the Giant Toad of South America. The upper parts, which are uniform brown or blackish, spotted with crimson during the breeding season, are covered all over with large spinose tubercles. According to Annandale it is generally found near human dwellings, occasionally penetrating into thick forest country. The young are much lighter in colour than the adults, and are often found in large numbers on the banks of rapid mountain streams, where they harmonize so well with the sand that they are difficult to detect except when in motion.

Several of the arboreal toads of the African and Southern Asian genus *Nectophryne*, which may be distinguished by the fact that the tips of the digits are dilated into regular discs, bring forth active young, the metamorphosis being undergone in the uterus. Dr. Krefft, who has kept specimens of *N. tornieri*, of East Africa, informs us that a specimen of his after pairing acquired extremely distended flanks, under the skin of which the wriggling movements of the larvæ could be clearly noticed.

Most of the two hundred frogs which make up the family HYLIDÆ are arboreal, and have the tips of the fingers and toes more or less dilated; the terminal phalanges are slender and claw-shaped. The upper jaw is toothed. The sacral vertebræ are dilated.

In *Hyla*, the type genus, the fingers may be free or webbed; the toes are webbed, usually to a considerable extent. The pupil is horizontal. The tongue is entire

or only slightly nicked. The tympanum is distinct or hidden. The family is cosmopolitan, except for the Æthiopian and the greater part of the Indian regions. Most of its members are small in size, although *H. maxima* of British Guiana, and *H. vasta*, of Hayti, attain a length of over five inches.

The COMMON TREE-FROG, *H. arborea*, ranges from Western Europe, North-West Africa, Madeira, and the Canary Islands to China and Japan. This frog, which attains a maximum length of not much more than two inches, has the head much broader than long; the snout is short and rounded, and scarcely projecting. The tympanum is distinct. The fingers are webbed at the base, the terminal discs equalling the tympanum in size. A strong fold separates the hand from the forearm above. The skin is perfectly smooth above, granular on the belly and under the thighs. The male is distinguished by a large external subgular vocal sac, which, when empty, forms folds, but when blown out resembles a bladder, and which is then considerably larger than the creature's head.

This frog, which is normally uniform bright green above, has the power of not only changing colour, becoming at times silvery white, yellow, or dark brown, but also of putting on temporary light or dark spots. In the variety *japonica* of Japan and China, however, dark spots on the back and cross-bars on the limbs are always present. Bright blue specimens are sometimes met with, due, as mentioned when dealing with the aberration in the Edible Frog, to the absence of yellow pigment.

In Central Europe the breeding season extends from the beginning of April to the middle of June, during which

time the croaking of the males is very loud and may be heard miles off. The eggs, deposited in deep ponds or pools of clear water, are attached to weeds below the surface in lumps about the size of a walnut, each female producing from 800 to 1,000 eggs. The tadpoles, which grow to a total length of about an inch, metamorphose late in the summer, the young frogs secreting themselves in holes in the banks, in which they spend their first winter.

Although a very powerful jumper, owing probably to its protective coloration, the European Tree-Frog makes no attempt to escape when detected; it does exceedingly well in captivity, feeding on flies and mealworms, and a case has been recorded of a specimen living for twenty-two years in quite a small cage. In Germany the frog is commonly kept as a barometer in cylindrical glass jars provided with a ladder, which the frog is supposed to ascend or descend and thus forecast the weather. In spite of the fact that its skin produces a fairly powerful acrid poisonous secretion, even those who have repulsion for other frogs and toads are disposed to make a pet of this species.

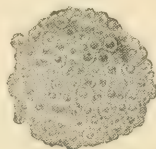


FIG. 17.—Eggs
of Common
Tree-Frog.

(After Boulenger.)

GOUGH'S TREE-FROG, *H. goughi*, of Trinidad, one of the smallest members of this genus, attaining a maximum length of just over an inch, was recently described by the writer, who was fortunate enough to possess several specimens, and was thus able to observe the most wonderful and rapid changes which this species undergoes, probably unparalleled by any other batrachian. The same individual may vary dorsally from dark brown, reddish-brown, various shades of yellow, to a very pale greyish-white. When startled the majority became of a bright lemon

yellow. In one specimen I observed the head, fore limbs, and anterior part of the body to be dark brown, whilst the posterior part of the body and the hind limbs were greyish-white. In another specimen the right half of the body was brown, the left half greyish-white. A dark marking, usually hour-glass-shaped, extending from between the eyes to the anterior third of the back, is frequently present, appearing and disappearing with great rapidity.

These Tree-Frogs were extremely agile in their movements, making leaps of quite six feet. In the daytime they kept quiet, sticking to the leaves or glass of their terrarium ; they issued at intervals a sharp, creaky note.

WHITE'S TREE-FROG, *H. cœrulea*, widely distributed over the greater part of Australia, is a large species, attaining a length of over four inches, and is very commonly imported to this country. In spite of its specific name it is bright green in colour, and not blue, the latter colour being restricted to spirit specimens. The head is very broad, and the tympanum is large, measuring two-thirds the size of the eye. The discs of the fingers and toes are very highly developed, being sometimes even larger than the eye. The skin is perfectly smooth and very shiny, and thus, when the animal is sitting motionless, it gives one the impression of being made of wax. The male of this species is provided during the breeding season with large horny spines, situated on the inner side of the first finger.

White's Tree-Frog does exceedingly well in captivity, feeding greedily on all kinds of insects and on small worms. Dr. Gadow's specimens would also take snails, vomiting out the shells in the form of pellets, some fifteen hours later. The eggs of this frog are laid in round, frothy masses, which float on the surface of the water.

H. infrafronata and *H. humeralis*, both of New Guinea, are closely allied to the preceding species; they are remarkable for the males being provided with a sharp, bony pointed process, situated, in the case of the former species, in the middle of the breast bone, in the latter, on the inner side of the forearms, secondary sexual characters which must have some connection with the nuptial embrace.

Many of the Tree-frogs of this genus have most interesting breeding habits. In *H. gældii*, of Brazil, and *H. evansii*, of British Guiana, the eggs, about twenty in

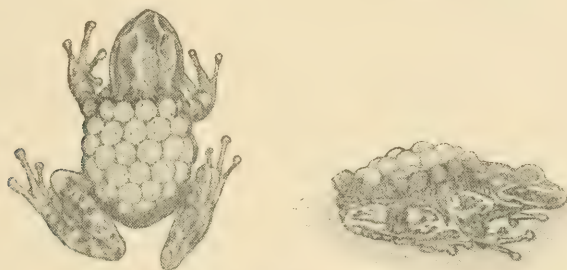


FIG. 18.—*Hyla gældii*, female with the eggs.

(After Boulenger.)

number, are carried by the female on her back. The metamorphosis takes place within the egg, the young emerging, but for a fairly longish tail, in the perfect state.

H. faber, known as the "Ferreiro" or "Smith" in Brazil, from its voice, which sounds like the regular beating of metal plates, builds circular nurseries, surrounded by walls of mud, in the shallow water of large ponds, and in which the eggs are deposited and thus protected from fishes and other enemies. These walls are built by the female, who makes use of both belly and hands for the purpose of smoothing the inside of the walls, and for the levelling of the bottom of the enclosure.

The GOLDEN TREE-FROG, *H. aurea*, of Australia, one of

the most beautiful of all frogs, being bright green, with spots and streaks of golden bronze, differs much from most of the other members of the genus, and agrees, both in general shape, as well as in its habits, with the Edible Frog of Europe. The discs of the fingers and toes are small, and are not much used for climbing. Unlike most Tree-frogs, this species keeps to the borders of stagnant ponds, and is seldom found on trees or bushes. The note of the male is somewhat similar to that of the "Ferreiro," *H. faber*, and resembles the mallet and chisel sounds of a number of stonemasons. The late Prof. McCoy, of Melbourne University, relates a story of how, when a large building was being erected close to his house, a newly arrived servant of his, writing home an account of the busy scene, mentioned that the masons could be heard at work the whole of the moonlight nights—so completely alike was the sound of the Golden Tree-Frogs in an adjoining pond, at night, to the noise of the men by day. In summer the note is also said to resemble the "clunk" of the cattle bells, and the farmers seeking their cows at dusk are said to have great difficulty in telling the one from the other.

The feeding habits of the *H. aurea* are similar to those of the Edible Frog, its food consisting almost entirely of earthworms and other small frogs.

H. venulosa, of Tropical South America and the West Indies, has the upper surfaces remarkably warty. It never evades capture, but relies on covering itself with a very pungent and sticky lather in defending itself from its enemies.

The Tree-frogs of the genus *Phyllomedusa*, represented by some fifteen species, inhabiting Tropical America, may

be distinguished from those of the preceding genus by their vertical pupils. The tongue, which is oval in shape, entire, or slightly nicked, is extensively free behind. The fingers and toes are free or only slightly webbed, and the tips are dilated into regular discs. These frogs are very remarkable in the fact that they are really *quadrumanus*, the inner digits of both the fore and hind limbs being opposable to the others in a monkey-like fashion, there being little difference in appearance between hand and foot.

Ph. iberingii does not lay its eggs in the water, but deposits them on leaves overhanging stagnant ponds, into which the larvæ fall when sufficiently developed. The egg-mass, containing large white ova, are wrapped up between two or three leaves, in such a manner as to be, but for a small inferior opening, completely enveloped.



FIG. 19.—Eggs of *Phyllomedusa iberingii*.

(After von Ihering.)

According to Dr. von Ihering, the moderately loud voice of this creature resembles somewhat the sound produced by running the finger-nail over the teeth of a comb. It is only seen during the breeding season, as at other times it establishes itself high up in the trees.

The six Tree-frogs of the genus *Nototrema*, also of Tropical America, have all the characters of *Hyla*; the

females, however, are provided with a dorsal pouch. As the breeding season approaches the skin on the female's

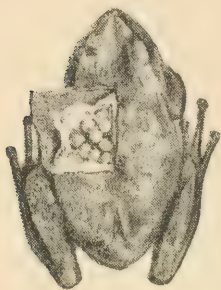


FIG. 20.—*Nototrema marsupiatum*.
(After Günther.)

back folds over in the form of a horseshoe in front of the vent and proceeds to distend until, in some species, almost the entire back forms a pouch for the reception of the eggs. In some forms the entire metamorphosis takes place within the pouch, whilst in others the young are liberated in a larval stage, and complete their metamorphosis in the water. In *N. cornutum*, *N. oviferum*, and in *N. testudincum*, the young, up to the time

of their liberation, breathe by means of a pair of large funnel-shaped membranes, connected with the first two gill-arches by means of a pair of long, thin tubes.

In the family PELOBATIDÆ, the upper jaw is toothed; the transverse processes of the sacral vertebra are strongly dilated. The pupil is always vertically elliptic. The family, which is represented by seven genera, inhabiting Europe, Southern Asia, New Guinea, and Northern and Central America, occupies an intermediate position between the *Discoglossidæ* and the *Bufo*nidæ.

There are two European genera, namely, *Pelodytes* and *Pelobates*; the members of the former are easily distinguished in being slender and frog-like, with deeply cleft



FIG. 21.—Young of *Nototrema cornutum*, showing bell-shaped gills.
(After Boulenger.)

toes, and a more or less distinct tympanum, the latter in being stout and toad-like, with broadly webbed toes and no tympanum.

The PARSLEY FROG, *Pelodytes punctatus*, is greyish or pale olive above, with small irregular bright green spots, which are occasionally confluent into more or less regular cross-bars on the limbs; an X-shaped light marking is usually distinct on the back. The male differs from the female in having a shorter body, longer and more robust fore limbs, and in the presence of an internal vocal sac,

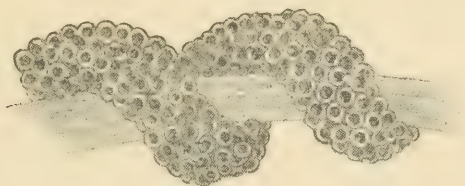


FIG. 22.—Eggs of the Parsley Frog.

(After Boulenger.)

which communicates with the mouth through a long slit on each side of the tongue.

The Parsley Frog, which is abundant throughout France, Spain, and Portugal, is thoroughly nocturnal, and is only met with in the daytime during the breeding season. It jumps in the manner of true frogs, swims well in spite of its free toes, and is a good climber, ascending smooth surfaces to which it adheres by means of its abdominal surface. The breeding season commences as early as the end of February, and lasts until the beginning of April; it has also been recorded as having bred in July, August, and September. The eggs, deposited in stagnant water, are rather small, and are laid in two strings, forming a band, which are twined round weeds below the surface

of the water. The outer envelope, which in toads forms a tube protecting the eggs, is absent. The number of ova in a brood varies in number from 1,000 to 1,500.

In *Pelobates*, represented by three species, two from Europe, and one from Asia Minor and Syria, the toes are extensively webbed. The tubercle at the base of the first toe is hard and shovel-shaped.

The COMMON SPADE-FOOT, *P. fuscus*, a thoroughly burrowing creature, spending most of its existence many feet underground, inhabits various parts of Northern, Eastern, and Central Europe, in districts where the soil is loose and sandy. The head is very broad; the eyes large and prominent; the hind limbs are short and very robust, with swollen calves. The skin is smooth on the head and limbs, usually covered with a few small fat warts of unequal size on the back. The coloration varies greatly. The ground colour may be olive, pale or dark brown, yellow or yellowish-white; dark brown or reddish spots, which sometimes are confluent into a pair of longitudinal bands, are usually present.

In the summer months this creature may often be met with at dusk in suitable localities, hopping about like a frog. When suddenly seized it produces a dermal exudation smelling exactly like garlic. Some specimens, when teased, will jump about open-mouthed, snapping at their persecutor, and, with their body swollen like a balloon, will utter loud, shrill cries which can only be compared to those of an infant.

The eggs, deposited round the weeds of small ponds, are expelled in a thick band. The breeding season commences towards the middle of March, and lasts until the end of May. The tadpole, which grows to a very large

size—up to four and a half inches in length—transforms in most cases towards the end of the summer.

The SOUTHERN SPADE-FOOT, *P. cultripes*, of Western and Southern France, Spain, and Portugal, differs from *P. fuscus* in being rather larger proportionately and in the skull being more strongly ossified; the digits are somewhat more obtuse and the shovel-shaped tubercle still sharper and larger, and always of a shiny black. The skin is smooth and covered with small round warts. The coloration is somewhat similar to that of the commoner species, but the markings are more olive than brown, and very rarely confluent into longitudinal bands.

Although more partial to the coast, the habits of *P. cultripes* are similar to those of its congener. The eggs differ slightly in the mucilaginous band being narrower.

The AMERICAN SPADE-FOOT, *Scophiopus solitarius*, of the Eastern United States, differs from the members of the genus *Pelobates* in the presence of a tympanum, and, in the case of the male, of a subgular vocal sac. The coloration is brownish above, marbled with darker.

This batrachian burrows in a similar manner to *Pelobates*, and comes out only at night to feed. Unlike the two species of the European Spade-Foot, when irritated it never produces loud cries, but, on the contrary, assumes a peculiarly humble attitude, bending its head and shutting its eyes.

The frogs of the genus *Megalophrys*, of South-Eastern Asia, represented by eight species, which differ much in size, some measuring not much more than an inch in length, while others attain a length of four or five inches, have the toes entirely free; the tympanum is hidden. In most species the skin becomes entirely adherent to the skull, while on the back it is hardened by bony deposits.

M. nasuta, the largest species, is remarkable for the great length of the horn-like flaps of skin, situated above the eyes, and for the presence of a similar appendage on the tip of the snout. H. O. Forbes, who has observed this frog in Sumatra, states that its anvil-clinking "Kang-kang" fills the air in the evenings, but it so closely simulates the dead leaves among which it lies, that it is most difficult to find.

M. longipes, which attains a maximum length of but two inches, is only known from the mountains of Perak, at an altitude of between 3,000 and 4,500 feet. It is said to be entirely nocturnal, appearing quite bewildered by the sunlight, and in the daytime retires under logs and rocks. In spite of its small size, this batrachian is believed to lay the largest eggs on record among frogs, the diameter measuring thirteen millimetres; they are deposited in clusters of about a dozen in tree trunks, or under damp moss, and the young emerge fully transformed.

Several of the species of this genus—*M. parva*, *M. nasuta*, *M. montana*—lay their eggs in fast-running streams, and the tadpoles are provided with strongly enlarged suctorial lips, by means of which they are able to cling to fixed objects, even in the immediate vicinity of waterfalls.

The family DISCOGLOSSIDÆ differs in many respects from the preceding, and is best characterized by the presence of short ribs on the anterior vertebræ. The tongue is circular and almost entirely adherent. The processes of the sacral vertebræ are very strongly dilated.

The type genus *Discoglossus* is represented by a single species, the PAINTED FROG, *D. pictus*, which inhabits Southern Europe and North Africa. It occurs nearly all

over Spain and Portugal, penetrating into a small corner of France, east of the Pyrenees ; it is also found in the islands of Sicily, Sardinia, Corsica, and Malta. In Africa its range extends all over Morocco, Algeria, and Tunisia. It inhabits the mountain regions as well as the plains, having been recorded in Corsica at an altitude of 2,500 feet. This frog greatly resembles the Common Frog, both in shape and size. The snout is, however, rather more prominent, and the tympanum is very often concealed under the skin. The moderately large eye is provided with round or triangular pupil. The upper parts are perfectly smooth.

The coloration varies considerably, and may be pale brown, grey, pale olive, yellowish, or reddish above, uniform and with dark, often light-edged, spots ; a dark streak is constant on each side of the head ; the limbs are transversely barred with darker ; a pale vertebral streak is sometimes present.



FIG. 23.—Eggs of the Painted Frog.
(After Boulenger.)

The Painted Frog, a very active batrachian, is usually found in the water, frequenting small brackish pools as well as running mountain streams, and, unlike the majority of frogs and toads, feeds under water. The breeding season extends, in North Africa, from January to the end of September, the female frequently spawning on as many as three occasions in the course of the year. The eggs, which are remarkable for their small size, are produced singly, and adhere to the bottom of the pond ; they are seldom attached to weeds. The larvæ transform rapidly, leaving the water in from one to two months.

Bombinator is represented by four species ; two are European ; one occurs in North-Eastern Asia, from Man-

churia to Northern China, while the fourth is restricted to Southern China. The processes of the sacral vertebra are still more strongly dilated than in *Discoglossus*. The pupil is roundish, triangular, or heart-shaped. The tympanum is absent. The fingers are free, the toes webbed.

The two European forms, the FIRE-BELLIED TOAD, *B. igneus*, and the YELLOW-BELLIED TOAD, *B. pachypus*, which for so many years were confounded under the specific name of the former, are easily distinguished, apart from the coloration of their under-surfaces, by the length of tibia, which is shorter than the foot in *B. igneus*, as long as, or longer, in *B. pachypus*. Males of the former species may be further distinguished by possessing internal vocal sacs, which are absent in the latter. Both toads are quite small, attaining a maximum length of only two inches.

The Fire-bellied Toad is dark olive or blackish above, while the lower parts are marbled with orange or vermillion, and black; a few white spots are sometimes present; it inhabits the low-lying parts of Russia, west of the Volga, Southern Sweden, Denmark, North Germany, and Austria Hungary, and is never found in hilly districts, where it is replaced by the Yellow-bellied Toad of Central and South-Eastern Europe, from North Brittany to Southern Greece; in the latter species the lower parts are marbled black and bright yellow.

Both forms spend the greater part of their existence in the water, but whereas *B. igneus* is always found in small ponds or pools of clear water, *B. pachypus* will frequent any sort of pool, clear or dirty, and the writer has frequently caught specimens in small rain puddles in cart-ruts of roads.

The eggs, which in both species are rather large, numbering eighty to one hundred to a brood, are laid from the middle of May to the end of July. The larvæ escape from the egg-envelope after about a week, provided with small external gills and a well-developed tail. Transformation takes place in the autumn.

B. igneus, as well as its congener, *B. pachypus*, do exceedingly well in captivity, living for as many as twenty years, and feeding on almost any moving object they are capable of swallowing. When freshly captured, specimens of both species will often feign death. Having gone through various ridiculous contortions, they will bend their spines, turn up their heads, and the hinder part of their bodies and limbs, thus exposing the brilliant markings of their under-surfaces, and in this position will remain perfectly motionless for a considerable time.



FIG. 24.—Eggs of the Yellow-bellied Toad.

(After Boulenger.)

B. maximus, recently discovered in Southern China, is the giant member of the genus, attaining a length of four to five inches. Its coloration is much the same as that of *B. igneus*.

The skin of all these toads is very warty, and produces an acrid secretion, freshly caught specimens becoming covered with a white froth, which causes fits of sneezing and running of the eyes.

Alytes, a European genus, is represented by two essentially nocturnal species, *A. obstetricans* and *A. cisternasii*, which may be distinguished from one another by several external characters. In these toads the skin is very tuberculate; the pupil is vertical; the tympanum distinct; the processes of the sacral vertebræ are much dilated; the fingers are quite free, the toes feebly webbed.

The MIDWIFE TOAD, *A. obstetricans*, a small greyish-green or pale brown toad, of about two inches in length, although seldom met with on account of its nocturnal habits, is abundant over the greater part of France, Spain, Portugal, Switzerland, Belgium, Western Germany, and South-Eastern Holland. It is found in the plains close to the sea, as well as in the mountains, ascending to an altitude of nearly 7,000 feet, where, but for two or three months in the year, the ground is covered with snow. The breeding habits of this toad, which were first described by Demours from observations made on specimens in the gardens of the Jardin des Plantes, and later, and more fully, by de L'Isle, in Brittany, where he spent more than fifty nights in the open in order to make his notes, are perhaps the most wonderful of all batrachians. Pairing takes place on land from April to August, when twenty to sixty eggs are laid in a rosary-like string. As they are expelled, the male, clasping the female tightly round the head, above the fore limbs, pushes his legs through the mass of eggs until they are firmly entwined round his limbs. Male and female then separate, and the former, laden with his burden, retires to some underground retreat, from which he occasionally ventures forth at night, in order to moisten the eggs in the wet grass, or to secure food. After about a month, the larvæ, which have developed within the egg-



European Burrowing Toad, *Pelobates fuscus*.



Horned Toad, *Megalophrys cornuta*.



Fire-bellied Toad, *Bombinator igneus*, shamming death.



Midwife Toad, *Alytes obstetricans*, with eggs.

capsules, are ready to hatch, and the father betakes himself to the water, where they are released in the form of advanced tadpoles, measuring about a quarter of an inch in length.

According to Kammerer, the eggs will develop in water if taken away from the parent, even just after oviposition ; and he has made the surprising observation that the offspring of the second generation will of their own accord go to the water for breeding purposes. The writer has on numbers of occasions taken away the newly laid eggs from the male and placed them in water, in order to repeat Kammerer's experiments, but never with success, the eggs dying after continuing their development for a few days.

The tadpoles are very large, measuring up to nine centimetres in length ; although specimens, amply provided with food, which I have kept, did not transform until over two years from the time they were hatched, in the wild state the majority do so within a year.

A. cisternasii, restricted to certain parts of Spain and Portugal, is somewhat stouter, and has a proportionately larger head ; it may also be distinguished from the commoner species by the presence of two palmar tubercles instead of three. Although the actual pairing has not been observed, the male has been found carrying the eggs, and, therefore, its breeding habits are, in all probability, identical with those of *A. obstetricans*.

Sub-order AGLOSSA : this sub-order of tongueless frogs is represented by a single family, the PIPIDÆ, which is divided into three genera, namely, *Xenopus*, of Tropical and South Africa, *Hymenochirus*, of Tropical Africa, and *Pipa*, of Tropical America.

In all three genera the eyelids and tympanum are absent ; the toes are very broadly webbed and pointed. The processes of the sacral vertebræ are much dilated.

They are perfectly aquatic animals, never leaving the water, even for feeding purposes.

The AFRICAN CLAWED FROG, *Xenopus lævis*, of South Africa, so called owing to the tips of its three inner toes being capped in horny, claw-like sheaths, has the perfectly smooth skin studded with tube-like sensory canals, as in larval frogs and toads. The upper jaw is toothed. The toes are remarkably broadly webbed, and when fully expanded resemble half-opened umbrellas. The head is small and the nostrils and lidless eyes are, as in most strictly aquatic animals, situated on the top of the head ; a very short, fleshy tentacle is situated below the eye. The coloration is dark brown or olive above, whitish beneath, immaculate or with brown spots. Females may be distinguished in having three fleshy flaps closing the vent.

When at rest *Xenopus* nearly always assumes an upright position, and scarcely ever a sitting posture. It feeds on insects, fishes, and even the young and larvæ of its own kind. Pairing takes place in South Africa in August, when about 100 eggs are laid singly, and attached to aquatic plants. The tadpoles, which have no beak or horny teeth, are remarkable in possessing long tentacles, situated on each side of the head, at the angles of the jaws just above the mouth ; these appear about a week after hatching, and, when fully developed, attain a length equalling that of the head and body.

According to Bles, who has published a long and detailed account of the life history of this frog in the *Transactions of the Royal Society of Edinburgh*, it may be fairly easily

induced to breed in captivity, if allowed to hibernate, and the following are methods employed: During the summer the *Xenopus* should be kept at a temperature of about 80°, in an aquarium covered with earth and stones, with abundance of aquatic plants, and given as much food as they will eat. In the winter the temperature should be allowed to sink to 55° during the day, and to about 40° at night, when the frogs will become very lethargic and refuse to feed. In the spring the aquarium must be raised to about 70°, when a certain amount of water should be drawn off morning and evening, allowed to cool, and then, by means of a syphon, drawn out to a fine point, to fall as spray into the aquarium, thus simulating rain. By carrying out these methods Bles obtained, during the months of April, May, and June, several thousand eggs from his specimens.

Xenopus calcaratus, of West Africa, is a much smaller species, attaining a maximum length of two inches. It is easily distinguished from the preceding by its extremely minute eyes, and by the presence of a very highly developed metatarsal claw, similar to those on the three inner toes.

The SURINAM TOAD, *Pipa americana*, has a very peculiar, extremely depressed, triangular-shaped head, with one or two short tentacles on the upper lid in front of the eye; a large fleshy flap is situated at the angle of the mouth, and another sometimes on the snout. The jaws are toothless. The fingers are very slender, and terminate in star-like appendages. The skin is rough, being covered with small tubercles.

The Surinam Toad has become notorious on account of its remarkable breeding habits, the eggs being fixed to the back in small pouch-like cavities in the skin of the mother.

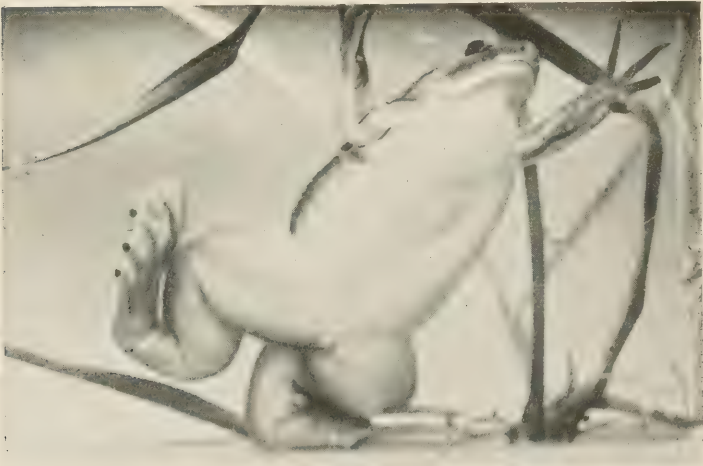
The following account of the breeding of specimens in our Zoological Gardens has been given by Bartlett: "About April 25 the males became very lively, and were constantly heard uttering their most remarkable metallic call-notes. On the following morning Tennant, the keeper, arrived in time to witness the mode in which the eggs were deposited. The oviduct of the female protruded from her body more than an inch in length, and the bladder-like protrusion, being retroverted, passed under the belly of the male on to her own back. The male appeared to press lightly upon this protrusion and to squeeze it from side to side, apparently pressing the eggs forward, one by one, to the back of the female. By this movement the eggs were spread with almost uniform smoothness over the whole surface of the back of the female, to which they became firmly adherent. On the operation being completed the males left their places on the females and the enlarged and projected oviduct gradually disappeared."

Although essentially aquatic, this toad is frequently found during the dry seasons in almost completely dried-up pools, when they may be easily captured.

Hymenochirus, recently discovered in Tropical Africa, agrees with *Xenopus* in the presence of claws on the inner toes, with *Pipa* in the absence of teeth. It differs from both in having the fingers webbed.



Clawed Frog, *Xenopus laevis*, dorsal aspect.

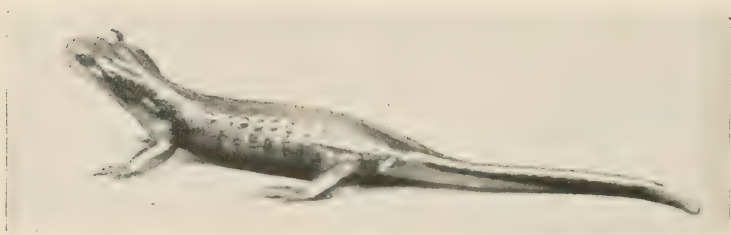


Clawed Frog, ventral aspect.

(a)



(b)



(c)



(a) Spotted Salamander, *Salamandra maculosa*.
(b) Black Salamander, *Salamandra atra*.
(c) Crested Newts, *Molge cristata*, male and female.

CHAPTER II

URODELA—TAILED BATRACHIANS

IN the Batrachians belonging to this order the tail persists throughout life ; they are provided with two pairs of limbs, exceptionally with only the anterior pair. The body is always more or less elongate, and those species in which the limbs are well developed suggest lizards by their shape, while those in which the limbs are very small and rudimentary are eel-shaped ; every intermediate stage, however, exists between the two extremes.

The Tailed Batrachians are divided into the following four families—

- I. The SALAMANDRIDÆ, which have no gills in the perfect form. Eyelids are well developed, both jaws are toothed, and four limbs are present.
- II. The AMPHIUMIDÆ, which likewise have no gills in the perfect form, have the jaws toothed, and both pairs of limbs are present. They have, however, no eyelids.
- III. The PROTEIDÆ, in which the gills persist throughout life. The jaws are toothed, and both pairs of limbs are present ; they have no eyelids.
- IV. The SIRENIDÆ, which also retain the gills. The jaws are toothless and covered by a horny sheath ; the eyelids and the hind limbs are absent.

In the SALAMANDRIDÆ, by far the largest family of the order, comprising the Salamanders and Newts, the eyelids are well developed, with the exception of *Typhlotriton*, in which they are concealed under the skin. The family, which is distributed over nearly the whole of the Northern Hemisphere, is divided into a number of sub-families, in accordance with the disposition of the teeth and the mode of articulation of the vertebræ.

In *Salamandra*, represented by two species in Europe and two in South-Western Asia, the tail is round and the tongue is short and thick. The toes are, as usual, five in number.

The SPOTTED SALAMANDER, *S. maculosa*, is generally distributed over Central and Southern Europe, up to an altitude of about 3,000 feet. The body, which is stout and rather depressed, is smooth and shiny, with a series of large pores along each side of the vertebral line, and with a lateral series of large warts separated by vertical grooves. The head is broad, and has a pair of well-developed parotoid glands. The general colour is black, with yellow or orange markings. The markings vary much in disposition, according to the creature's geographical distribution. In the typical form, which inhabits Southern and Eastern Europe and Asia Minor and Syria, the black nearly always greatly predominates over the yellow, which may appear as markings of various shapes, disposed over the body, often in three to five alternate series, or with a median series forming a sinuous or zigzag vertebral stripe. If, as is very exceptionally the case, the spots appear to form two longitudinal series, they do not hang together in regular chains continuous with the spots on the parotoids, which are always present. In the variety *tæniata*, of Central and

Western Europe, the spots are regularly disposed in two parallel series, continuous with the spots on the parotoids, forming not unfrequently uninterrupted stripes. Even when the two stripes are broken up into as many as a dozen spots, they still retain their duplex disposition, and do not encroach over the black vertebral area, or, if they do so, they are connected in H-like fashion by a cross-bar. Although in this variety the black often predominates over the yellow, it is not uncommon to find specimens in which the reverse takes place, and, in cases where the yellow has so far invaded the upper parts as to actually constitute the ground colour, the black vertebral stripe may be reduced to a mere series of spots. The colour in both these forms varies from lemon yellow to a deep orange. In Portugal a form appears, the variety *molleri*, in which the spots are as if powdered over with red dust; some are even blood red, the red colour being particularly conspicuous on the throat and on the spots of the upper eyelids, the parotoids, and those at the base of the limbs. On examination of some living specimens which I kept alive some years ago, I came to the conclusion that the red spots were not due to special pigment, as had been supposed, but to the entire absence of pigment, the pigmentless flesh, highly flushed with blood, being exposed on certain patches.

According to Kammerer, the geological, climatic, and meteorological conditions of the localities these animals inhabit, influence the markings and their disposition. A warm climate, he says, increases, a cold climate reduces the markings and their intensity; localities with damp air and soil, provided, in addition, with a great number of watercourses, favour the number, size, and intensity of the yellow spots, whilst, conversely, dryness and scarcity

of watercourses produce a decrease in these respects; further, a special increase of yellow colour and its intensity takes place on a clay soil, while, on the other hand, the reverse obtains on black humus. A study which the writer has made of the varieties of the species, in relation to its geographical distribution, has failed to confirm the views of Kammerer, and, therefore, further experiments in connection with this interesting subject are to be desired.

The Spotted Salamander spends the greater part of its existence hidden in holes in the ground, which it leaves, as a rule, only at night, or in the daytime just before or after thunderstorms, when incredible numbers may appear, crawling about in search of earthworms. The young, ten to forty in number, are born in the larval state, with large external gills, and small but well-developed limbs, and are deposited in brooks and springs, mostly during the months of March, April, and May. The female does not actually enter the water for the purpose of releasing her young, but merely takes a hip-bath, returning to her underground retreat immediately the operation is over. The larvæ, which are under an inch in length at birth, leave the water after about six months, when two to three inches in length. Their growth on land is slow, as they do not reach their total length or become sexually mature until nearly four years after their birth.

Provided not more than three or four specimens are kept together in a cage, this salamander does fairly well in captivity; if several, however, are placed together they very soon become covered all over with fungoid growths, from which they never recover.

The average sized Spotted Salamander measures five

or six inches in length ; a giant specimen which I saw in the Florence Museum, and which, for various reasons, I am inclined to believe was an Asiatic specimen, measured over a foot in length.

The BLACK SALAMANDER, *S. atra*, which lives in the Alps above 2,500 feet, differs from *S. maculosa* in the absence of spots and in its smaller size. It produces two young only, which are born in the perfect air-breathing condition, having fed *in utero* on the egg-yolk of their brothers.

In *Chioglossa*, represented by a single species, *C. lusitanica*, of North-Western Spain and Portugal, the tail, which is exceedingly fragile, like that of most lizards, is cylindrical at the base, compressed at the end. The body is very slender ; the limbs are weak. The skin is smooth and shiny, dark brown above, with two broad, reddish-golden bands along the body, continuing on the tail.

This Salamander, which grows to a length of only five inches, spends its entire life hidden under stones or moss, frequently in the neighbourhood of running water, into which it jumps when dug out of its hiding-place. Unlike most other Urodeles it is as active on land as almost any lizard, while in the water it is as rapid in its movements as the Newts. The larvæ are characterized by an exceedingly thin and elongate body, and by a low dorsal crest.

Molge, the Newts, are all aquatic, at least during the breeding season, when they resort to stagnant pools. In these creatures the tongue is free along the sides, adherent or more or less free behind. The toes are five in number. The tail is compressed and, in the case of most species, is provided with a crest. Many newts exhibit marked sexual dimorphism, as the males frequently differ from the

females in the possession of high dorsal crests, and other nuptial ornaments. When the breeding season is over they, as a rule, leave the water, and retreat to holes in the ground in the neighbourhood of the water, where they live on insects and worms.

All newts lay eggs, these being attached, usually singly, sometimes in small batches, to submerged weeds or stones. The larvæ leave the egg in from ten days to three weeks' time, according to the species and the temperature of the water. Although in some special localities the larvæ, instead of transforming, retain their larval form and breed in that condition, transformation as a rule takes place three or four months after hatching.

The genus contains twenty species, three of which are indigenous to Great Britain.

The COMMON NEWT, or SMOOTH NEWT, *M. vulgaris*, which attains a total length of from three to four inches, has the skin perfectly smooth. The male has a high and elevated festooned crest, which is continuous with that of the tail. In the female the crest is represented by merely a ridge. The limbs are moderately long, and the toes, which are free in the female, but bordered with lobes of skin in the male, are much depressed. The tail, which is a little longer than the head and body, is bordered both above and below with a crest, the upper part of which, in the male, is festooned like that of the back. The upper parts are olive brown, with round black spots in the male; the festoons of the dorsal crest are usually tipped with red.

The female has often a series of dark dots, or a dark line, on each side of the back. The lower parts are yellowish-white, with a median orange stripe, spotted with black; the spots, which are larger in the male than in the female,

frequently form, in the case of the latter, a continuous streak on each side. The throat is white or yellow, usually spotted with black. The lower edge of the tail is yellow or orange, and immaculate in the female, red, bordered above with blue, and barred with black, in the male.

The Common Newt has a very wide distribution; it is fairly abundant over the greater part of England, the South of Scotland, and Ireland, where it is the only species known; it is entirely absent from Wales. With the exception of the South of France, Spain, and Portugal, it is found locally over the greater part of Europe and temperate Asia.

In the north the breeding season begins late in March, towards the end of February in the south.

Under captive conditions this newt does not thrive, as it leaves the water as soon as the breeding operations are over, when it refuses all food, becomes very soon emaciated, and dies of starvation after only a few months.

The CRESTED NEWT, *M. cristata*, which has, in the British Isles, very much the same distribution as the Common Newt, but is absent from Ireland, has, in the case of the male, a very high and deeply toothed dorsal crest, which, in the female, is replaced by a longitudinal groove. The limbs are moderately long, with the fingers and toes free. The tail is as long as, or a little shorter than, the head and body; during the breeding season it is strongly compressed, with an upper and a lower crest, the upper of which, in the male, is sometimes denticulated like the one on the back. The skin is more or less strongly tuberculate, both above and beneath. The coloration is brown, blackish, or olive above, with usually distinct black spots; a yellowish vertebral line is often present in the female;

the sides are speckled with white ; the breeding male's head is marbled black-and-white. The under-surfaces are bright yellow or orange, spotted or marbled with black ; the fingers and toes are yellow, with narrow black rings. A silvery-white band in the breeding male extends along the side of the tail, the lower edge of which is uniform orange in the female.

The Crested Newt breeds in April, May, and June in the British Isles, somewhat earlier on the Continent. It also, unfortunately, does not do at all well in captivity, as, with a few exceptions, it leaves the water after the breeding season.

The variety *karelinii*, of Italy, Dalmatia, and North-Eastern Persia, which may be distinguished from the British form by its larger head and shorter body, is more aquatic, and lives for considerable periods in aquaria. In this variety the yellow vertebral line of the female is almost constant.

The PALMATED NEWT, *M. palmata*, the only one which is found over the whole of England, Wales, and Scotland, is the smallest British species, rarely attaining more than three inches in length. The skin, as in the case of *M. vulgaris*, is smooth, or nearly so. The head is as in the latter species, but the snout is broader. In the male the somewhat quadrangular body is provided with a low and entire vertebral crest ; in the female the body is nearly round in section, with a low ridge along the middle of the back. The toes are webbed in the breeding male, entirely free in the female. The crested tail ends in a short filament in the male. The general colour is brown or olive above, with small dark spots, which are very numerous on the head. The lower parts, except for the median zone of



Marbled Newt, *Molge marmorata*, male.



Marbled Newt, female.

the belly, which is yellow or orange, is uncoloured ; a few spots are sometimes scattered over the belly, but are never present on the throat, which is pigmentless, an important character to distinguish this species, in both sexes, from the Common Newt. The lower edge of the tail is yellow or orange in the female, bluish-grey in the male.

On the Continent the Palmated Newt is abundant over the greater part of France, Belgium, Holland, Switzerland, Western Germany, and Northern Spain.

As in the Common Newt, the breeding season of this species extends from the end of February to the end of May, after which it retires into some hole on the banks of the water.

The ALPINE NEWT, *M. alpestris*, a rather small species, measuring barely four inches in length, although ascending to a considerable altitude, is by no means restricted to the mountains, as its name would imply, but is found over the greater part of Central Europe, including the lowlands of Holland. The breeding male is ornamented with a low, straight-edged crest, which extends without interruption along the very strongly compressed tail. The skin is more or less distinctly tuberculate on the upper surfaces, which are bluish, dark green, brown, or blackish, usually uniform, but sometimes marbled with darker ; a lateral series of small black spots on whitish ground is constant in both sexes, and is, in the breeding male, bordered inferiorly with a sky-blue band ; the crest of the back is white, with round black spots ; the under-surfaces are uniform yellow, orange, or red. Like the majority of European newts, this species does not flourish in confinement.

The MARBLED NEWT, *M. marmorata*, which attains a larger size than the Crested Newt or the Alpine Newt, in-

habits the West and South of France, Spain, and Portugal. The breeding male has a straight-edged, much elevated, dorsal crest, replaced by a longitudinal groove in the female. Fingers and toes are free in both sexes. The tail, which is crested above and below, is much compressed, and a little longer than the head and body. The skin is covered above and below with tubercles. The general colour is bright or dark green above, marbled with brown or black; the crests of the back and upper portion of the tail are alternately barred with black and white; a yellow or orange vertebral streak is always present in the female; the fingers and toes are green, with black annuli; the lower surfaces are brown or greyish, with more or less distinct darker spots, and speckled with white.

Although the Marbled Newt usually takes to land after the breeding season, which extends from March to May, it nevertheless does quite well in aquaria, surviving several years of captivity.

In localities where both the Marbled and Crested Newts occur, hybrids between the two species are occasionally found, and these were, when first discovered, described as a new species, under the name of *Triton blasii*. The various characters of this hybrid are exactly intermediate between those of *M. marmorata* and *M. cristata*. The upper surfaces are dark green, marbled with dark brown, while the belly is orange, marbled with black. These hybrids have been recently obtained by Peracca and Wolterstorff by crossing captive specimens.

The JAPANESE NEWT, *M. pyrrhogastra*, which is common in Japan, and is also found in certain localities in China, has the under-surfaces of a bright carmine, with or without black spots. The body of this newt is quadrangular in

the male, but perfectly round in the female. The dorsal crest is absent, and is replaced in both sexes by a prominent vertebral ridge, produced by the great development of the spinous processes of the vertebræ.

The Japanese Newt lives for many years in captivity, and is annually imported to this country in large numbers.

The COMMON AMERICAN NEWT, *M. viridescens*, is very abundant in the Northern and Eastern States of North America. The body is rounded, without a dorsal crest, but with the vertebral line much swollen. The tail is much longer than the head and body, and is furnished with an upper and a lower crest. The inner surface of the hind limbs of the male are furnished with black rugosities. The skin is smooth, or minutely tubercular. The head is covered with deep pits, probably sensory organs, three on each side of the head being remarkable for their size. The upper parts are olive brown, with black spots; the lower surfaces are red or orange, dotted with black.

M. viridescens, when adult, is thoroughly aquatic, seldom leaving the water, in which it feeds almost exclusively on insects and small molluscs. The newly metamorphosed young, which are reddish in colour, spend their existence on land, concealed under stones and moss; they do not take to the water again until they reach maturity.

The CALIFORNIAN NEWT, *M. torosa*, a large form, attaining seven inches in length, the commonest newt of Western North America, is likewise very aquatic and does well in captivity. The body, which is granular above and below, is rounded and crestless; the long tail is provided with a very low upper and lower crest. The colour above is uniform brown; below, orange or yellow.

The PYRENEAN NEWT, *M. aspera*, is restricted to the

mountain lakes of the Pyrenees, which are supplied with running glacier water. The body is stout and crestless, while the tail, which is as long as the head and body in the female, shorter and thicker in the male, is destitute of a regular crest, being merely keeled above. The general colour of the upper-surfaces is dark olive, uniform, or with yellowish spots, which may be confluent into a broad vertebral line ; the lower parts are orange, with black spots.

Breeding takes place in the middle of summer.

The PLEURODELE NEWT, *M. waltlii*, of Spain, Portugal, and Morocco, which is very aquatic, thriving for as many as twenty years in captivity, is remarkable in having long and pointed ribs which, especially in the case of young specimens, frequently perforate the skin. The head is roundish and very much depressed. The body and tail are crestless ; the latter, which is longer than the head and body, is keeled above. The upper parts are olive, the lower surfaces yellow, with blackish markings.

Gadow states that he has caught these newts in Southern Spain and Portugal in rain-water cisterns, into which they fall and are unable to get out again.

Tylototriton, of Eastern Asia, differs from *Molge* in certain anatomical features.

In *T. verrucosus*, of the mountain regions, Yunnan, and of the Eastern Himalayas, the skin is covered with large tubercles, and the very broad and much flattened head is provided with a pair of large parotoid glands ; sixteen knob-like tubercles are situated on each side of the body. A broad and very prominent vertebral ridge is produced by the great development of the spinous processes of the dorsal vertebræ.

But for the lower edge of the tail, which is orange or

yellow, the coloration, both above and below, is of a uniform dark brown.

In *T. andersonii*, of the Loo Choo Islands, the ribs are, as in *M. waltlii*, long and pointed, and perforate the skin.

Amblystoma is represented by twenty species, which, with the exception of *A. persimile*, a native of the mountain regions of Siam, are inhabitants of either North or Central America. The majority resemble in shape the European Salamanders, the head being short and broad, with prominent eyes, while the somewhat heavy, elongate body is grooved laterally. The limbs are well developed, with five toes. The tail is more or less compressed and usually somewhat shorter than the head and body.

Like the true Salamanders the Amblystomes live concealed under moss, leaves, and stones, leaving their retreats but once a year, when they congregate in pools or ponds in order to lay their eggs.

A. tigrinum is one of the commonest species, being very abundant throughout North America and southwards to Central Mexico. The skin is smooth and shiny, black in colour, spotted or blotched with yellow; the under-surfaces are slate grey, with a few very small white spots.

The larva of this salamander, which attains a length of nearly a foot, is of peculiar interest on account of the fact that in Mexico, where it is known under the name of AXOLOTL, and where it forms a popular article of food, it rarely transforms, but remains in the water throughout life, breeding in the imperfect condition. Its head is very large and provided with three pairs of external gills; the tail is provided, both above and below, with a very broad fin, which, in the case of the former, is continued along the back to the head.

Although suspected by Cuvier to be but the larva of some unknown salamander or newt, the Axolotl of Mexico was for many years regarded as solely aquatic. In the year 1863 a number of living specimens were imported for the first time to Europe, where some of these, kept in the Jardin des Plantes, in Paris, bred and the young were successfully reared. At the time there seemed no possible doubt that the Axolotl, having bred in the branchiate condition, could be anything but a perfectly aquatic animal. It was not, however, until some two years later that the subject assumed a different aspect, for some individuals of the second generation lost their gills and the fins of the back and tail, developed eyelids and yellow spots on the skin, and finally took to land, transforming into the terrestrial salamander, already well known from North America, under the name of *Amblystoma tigrinum*.

A few years later, Mlle. de Chauvin, at Freiburg University, tried to solve the question as to whether it were possible to force the larvæ, if brought under conditions which rendered the use of the gills difficult, and that of the lungs easy, to change into Amblystomes, and, therefore, took several broods of Axolotls about six months old and placed them in large glass vessels, which were so disposed and the water so restricted that at one spot only could they dive quite under, while everywhere else they came into contact with the air. The water was then gradually reduced. Within a few days a change took place, the creatures leaving the water in from four to fourteen days, the complete metamorphosis following about ten days later. Mlle. de Chauvin summarized her results as follows: "From what I have said, the correctness of the view suggested by Weismann must be established, namely,

that most Axolotl larvæ, if not all, complete their metamorphosis, if in the first place they come out of the egg healthy and are properly fed, and in the second place, meet with arrangements which force them to change from breathing under water to breathing above water."

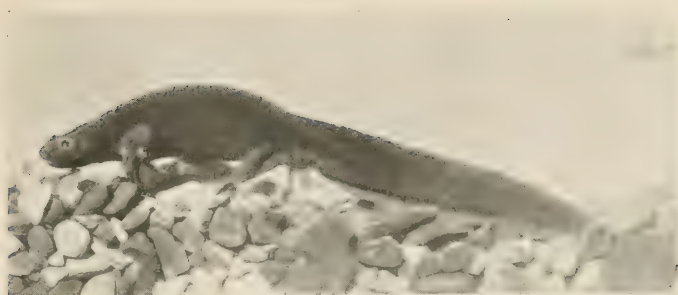
Dr. J. H. Powers at Doane College, Nebraska, has more recently conducted numerous experiments on the metamorphosis of North American examples of the Axolotl, and he has come to the conclusion that the metamorphosis is not due, as was thought by Mlle. de Chauvin, to a direct response to changes in conditions of environment, compelling them to resort to aerial respiration, but to checked nutrition, and that a careful study of Mlle. de Chauvin's methods and results seems to cast a doubt upon the conclusion that enforced air-breathing caused the metamorphosis. The following is a passage from Dr. Powers's paper on the subject of this lady's experiments: "Fearing that her charges would die, as indeed they sometimes did, she always prepared them for the trying ordeal of metamorphosis by raising the temperature of the water in which they were kept, and feeding to the maximum for several days, to which she ascribes no other importance than giving the animals increased strength. The Axolotls were then brought immediately into water sufficiently shallow as to force them, at least part of the time, to breathe air. In this latter condition the experimenter complains again and again that it was next to impossible to induce the Axolotls to take any food whatever. Thus, in these experiments, we have high feeding followed by practical starvation, and it seems that no control experiments were instituted to determine what the effects of over and under nutrition might have been with Axolotls still in abundance

of water. Yet most interesting is it to note that even the varying factors of nutrition seem to have been wholly neglected in the final interpretation of the results."

Dr. Powers's field-notes show that metamorphosis occurs rarely, if ever, as the result of enforced air-breathing through the drying-up of ponds, and that, in spite of repeated search at appropriate times and places, no Axolotls have been found transforming on the mud of drying ponds.

Dr. Gadow, who not long ago visited the lakes near Mexico City in which this creature lives, and where it is said to retain its branchiate condition, has been able to refute the theories framed by various zoologists, as to why the Axolotl does not transform in those localities. The reason he gives is that the unfailing abundance of food and water, and the innumerable hiding-places amongst the reeds under the banks, constitute for these batrachians a real paradise, where they remain, in spite of the fact that there is nothing to prevent them from leaving the water.

The writer has himself experimented on the metamorphosis of the Mexican Axolotl, and succeeded in obtaining the transformation of numerous specimens. His results showed that, in the first place, in accordance with Mlle. de Chauvin's observations, and contrary to those of Dr. Powers, the Axolotl will, with a few exceptions, transform into the Amblystome stage if placed, when about five inches in length, under conditions which force it to make free use of its lungs: in the second place, that starvation, irregular feeding, and temperature, all of which have been stated or suggested to cause the creature to transform, has no influence on the metamorphosis:



Pleurodele Newt, *Molge waltlii*.



Burmese Newt, *Tylotriton verrucosus*.

(a)



(b)



(c)



(a) Axolotl, *Amblystoma tigrinum*.
(b) Axolotl (albino), intermediate stage.
(c) Transformed Axolotl.

thirdly, that no change takes place when the creature is placed in water from which the necessary oxygen has been eliminated, showing that the quantity of oxygen in the lakes of Mexico can have little bearing on the phenomenon. The shrinking gills and fins, I found, could be made to undergo fresh development in the early stages of the metamorphosis, by replacing the animals into deep water after they had been forced to breathe air, when the previous stages in the development were resumed in just half the time required to reach them.

The Axolotl breeds freely in captivity, the eggs, about 100 in number, laid in the early winter or spring, being attached in bunches of about half a dozen to aquatic plants. The animals can almost invariably be made to breed by keeping them in small tanks without any plants, and then suddenly transferring them to large aquaria well supplied with vegetation. The eggs are hatched in from ten to twenty days, according to the temperature of the water. The larvæ, which at first should be given *Daphnia*, and later worms, grow rapidly, and are sexually mature when about a year old.

It is a peculiar fact that the fingers and toes of regenerated limbs are often webbed instead of being free, as in normal specimens, and consequently the ancestral Amblystome is believed to have had webbed feet.

A. altamirani, which lives close to the haunts of *A. tigrinum*, in the mountain streams, up to an altitude of 10,000 feet, is yellow and black, like the latter species, when half grown, but when fully adult becomes grey, with black spots. This species, although transforming when only five months old, is essentially aquatic. Dr. Gadow

states that the larvæ are not found in the clear, running streams inhabited by the adults, but are confined to quite muddy water, overrun with watercress and similar weeds.

Salamandrina, represented by a single species, *S. perspicillata*, of Italy, differs from *Molge* and *Amblystoma* in the possession of but four toes. The slightly compressed tail is very long, much longer than the head and body, and is keeled above. The head is very distinct from the neck, with large prominent eyes. The limbs are weak. The skin is closely tuberculate above and beneath. The upper surfaces are dark brown or black, with a yellow, spectacle-shaped marking on the top of the head, between the eyes; the belly is white, with black markings; the under-surface of the tail is usually pink, sometimes red.

The Spectacled Salamander, as this creature is called, from the marking on its head, is found in the neighbourhood of streams, into which it enters but once a year in order to deposit the eggs. The larvæ closely resemble those of the Spotted Salamander.

Hynobius, a Japanese genus, is more or less aquatic. The hind limbs are provided with five digits; the tail is cylindrical at the base, compressed at the end.

H. keyserlingii is remarkable for the fact that, during the breeding season, the eggs are surrounded by a gelatinous substance, forming a bag, which is suspended from the branches of some tree or bush overhanging the water. The anterior end of this receptacle, which measures six inches in length and barely one in breadth, is submerged, and thus the larvæ, when they have reached a certain stage in their development, break through the bag and find themselves in the water.

Spelerpes, occurring in Europe and Central and South America, is a genus composed of about twenty Salamander-like creatures, noteworthy on account of the fact that they are able to shoot out their tongues to a very considerable distance. The limbs are more or less well developed, with five toes.

The EUROPEAN SPELERPES, *S. fuscus*, of the South-Eastern parts of France, Italy, and Sardinia, has a long head, with a distinct swelling beneath each nostril, which is much enlarged in young specimens. The fingers and toes are short, somewhat dilated at the end and about half webbed. The tail is cylindrical, shorter than the head and body. The animal, which is brown above, uniform, or with pink spots, grows to a length of only four inches. It usually makes its home in limestone caves, where it catches the small insects upon which it lives, these being obtained by shooting out the long tongue in a chameleon-like fashion. The young are brought forth in the perfect condition.

The COMMON AMERICAN SPELERPES, *S. bilineatus*, which is abundant in the Eastern United States, has the fingers and toes entirely free. The general colour is yellowish, with two lateral dark brown bands commencing from the eyes and extending along the tail.

According to Wilder, it is found in or about running brooks, supplied with small stones, and seems to prefer spots shaded by trees, the best brooks being the little mountain streams that run swiftly down quite steep inclines, forming miniature cascades, alternating with small shallow basins. Search for the creatures should be made under stones lying on the edge of the brook, with the

bottom surface just below the level of the water. Many such stones when lifted up reveal a shallow cavity formed in the wet sand, and in these cavities the *Spelerpes* are frequently found.

Unlike its more terrestrial relative, *S. fuscus*, this species, in common with most of the other members of the genus, is oviparous; the eggs, deposited in a single layer of about forty or fifty, are laid under arched stones in the rapidly flowing portions of the brook; the depth of the water must be such that the eggs are at all times completely submerged, for otherwise they would be injured by the ripples striking against them. The larvæ hatch early, and continue in the imperfect state for several years.

The family AMPHIUMIDÆ, which is represented in the United States and Eastern Asia, contains three genera, each with a single species.

In the perfect form the gills are absent, although gill openings are sometimes present. The fore and hind limbs are more or less well developed. The teeth are present in both jaws.

In *Megalobatrachus*, represented by a single species, the GIANT SALAMANDER, *M. maximus*, of China and Japan, the gill openings are absent. This, the largest of living batrachians, attaining a length of over five feet, inhabits swift-running streams, where it leads a solitary life, concealed in dark holes under the rocks of the banks. The head of this creature is large, very broad, and depressed, and with a rounded snout; the eyes are minute. The tongue covers the floor of the mouth, and is entirely adherent. The body is long and squat, with a fold of

skin on each side, which undulates in the water during locomotion; the limbs are short and bordered with membranes. The tail is very strongly compressed, finned, and with the end rounded. The skin, which is brown, spotted with black, is very tubercular, the tubercles being largest and most prominent on the head.

The animal is closely related to the Great Salamander of the Miocene of Oenigen, originally described by its discoverer as a fossil man, "*Homo diluvii testis*," regarded by him as "*ein recht seltenes Denkmal jenes verfluchten Menschengeschlechts der ersten Welt*."

According to Sasaki the Giant Salamander is eaten by the Japanese, and may be easily captured with a fish-hook baited with fish, frog, or worm, and tied to a string a few feet in length. When captured it emits a peculiar slimy secretion, which hardens into a gelatinous mass on short exposure to air.

The eggs, laid in August and September, form a rosary-like string, each egg measuring six millimetres in circumference, being connected with the next by a small string. The Giant Salamanders in the Amsterdam Aquarium bred a few years ago, when Dr. Kerbert, of that institution, was able to witness the parturition and development. The care of the eggs devolved on the male, the latter occasionally getting under them and lifting them up for the purpose of aeration. The larvæ left the eggs when about an inch in length, provided with external gills and rudiments of limbs.

In *Cryptobranchus*, of the Eastern United States, which does not attain quite so large a size as *Megalobatrachus*, the neck is pierced by a pair of small holes.

According to Bertram Smith, who has given a very full account of the life history and development of this animal, it leads very much the same sort of existence as its Japanese relative, spending the greater part of the day in crevices under large rocks. He says that the cavity used as a dwelling-place has the rock for its roof and the bed of the stream for its floor. As a rule ready-made caverns are chosen, which are reached by a natural opening, but the cavity often bears evidence of having been hollowed out by the animal, and is sometimes reached by a single, burrow-like entrance. The Hellbender, as this creature is often called, is very nocturnal, and seldom comes forth in the daytime, except during the breeding season, *i. e.* August and September.

Its food consists of fishes and crayfishes; it will also eat frogs and even its own larvæ and young. The epidermis, which is shed at frequent intervals, is invariably eaten, a not uncommon habit among the Urodeles. The breeding season lasts a fortnight, when about four hundred eggs, which form a much-twisted string, are deposited in the caves under the rocks. The male remains with the eggs after fertilization, protecting them from the mother, who would otherwise devour them; even the male, however, is often tempted, and devours a small number of the eggs, although never the lot. The eggs, kept by Smith at a temperature of about 50°, hatched about six weeks after they had been laid, when the embryos were thirty millimetres long; six months later they measured forty millimetres. After this period they grew at a much faster rate, and attained a length of six to seven centimetres long in a year.

Amphiuma, an eel-shaped relative of the Giant Salamanders, inhabits the swamps and muddy rivers of the South-Eastern United States, growing to a length of three feet. The very rudimentary limbs are provided with only two or three fingers and toes. The head is small, with an elongate snout ; the eyes are very small. The tail is short, compressed, and keeled above. The uniform, blackish-brown skin is smooth and slimy, and it is quite an impossibility to hold the wriggling creature in one's hand for more than a few seconds.

The *Amphiuma*, which is regarded by many of the country people as a highly poisonous snake, leaves the water late in the summer, when the eggs, deposited in clumps formed of two intertwined strings, are laid on land, and are protected by the female, who coils herself round them. The eggs hatch after a period of about three months, when the three-inch-long young are provided with external gills, which disappear in about six weeks' time.

The *Amphiuma* is very hardy, and will live almost indefinitely in a small aquarium on a carnivorous diet.

The animals of the thoroughly aquatic family *PROTEIDÆ* retain their gills throughout life. Eyelids are absent.

The family is represented by two genera, namely, *Necturus*, of North America, and *Proteus*, of Austria, which may be distinguished as follows—

Necturus, eyes exposed ; digits 4-4.

Proteus, eyes hidden ; digits 3-2.

Necturus maculatus, of the Eastern United States, has the eyes functional, although minute. The limbs are

fairly well developed. The tail is long and finned. The animal, which has a rather elongate body, is chestnut-brown, with large dark spots. The gills are very well developed and the long fringes are bright red in colour. The animal is more or less nocturnal, and I have known captive specimens, when placed in strong light, to burrow under the shingle of their aquarium until their heads were entirely hidden. Although unable to live more than a few hours on land, the amputation of the gills does not in any way inconvenience specimens kept in water, the gill-less animals breathing through their skin.

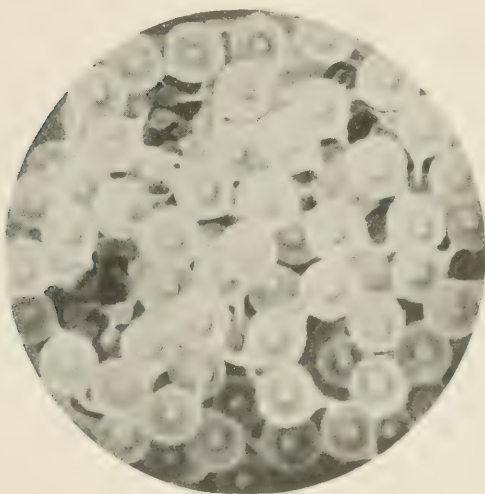
Necturus occasionally attains a length of two feet; it feeds on tadpoles, worms, and small crustacea.

The PROTEUS, *Proteus anguinus*, is restricted to the subterranean waters of the caves in the mountains to the east of the Adriatic, where it lives in complete darkness. In accordance with its subterranean life, Proteus is perfectly blind, while its skin, although containing dark pigment in a latent condition, which appears on the surface when the animal is exposed to the light for any considerable time, is normally flesh-coloured. The body is very slender and elongate; the tail is short, strongly compressed, and finned. Its maximum length may be put down at about eighteen inches.

Proteus is usually oviparous, laying some fifty eggs, which hatch after a period of about ten weeks. The larvæ, measuring under two inches in length, have but two fingers, the third appearing only at a much later date; the eyes are more exposed than in the adult animal. Although oviparous in the cool waters of the caves it inhabits, Kammerer has found that at a comparatively high



Giant Salamander, *Megalobatrachus maximus*.



Eggs of Giant Salamander.

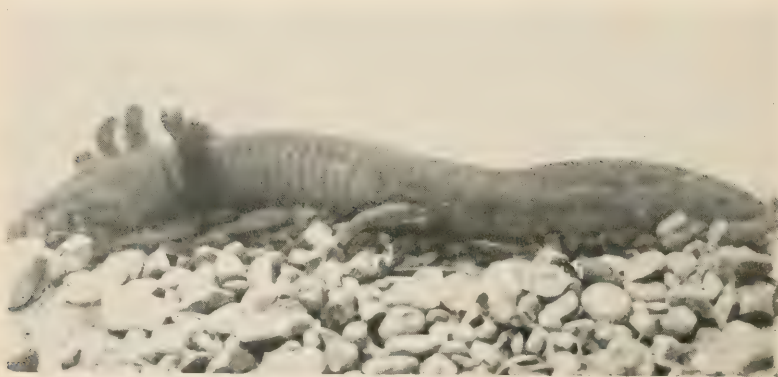
(a)



(b)



(c)



(a) *Amphiuma*, *Amphiuma means*.

(b) *Proteus*, *Proteus anguinus*.

(c) *Menobrach*, *Necturus maculatus*.

temperature the eggs are retained, and the young are born alive in an active condition.

In spite of the fact that in captivity *Proteus* often refuses to feed, it will thrive nevertheless without taking any form of nourishment at all for as long as five years. The writer one day offered some of his specimens, which had not fed since their captivity, a period of over two years, some larvæ of midgets; these were at once greedily accepted, and now the specimens in question feed weekly with the greatest regularity. In its native haunts *Proteus* is said to subsist entirely on small crustacea.

The members of the family SIRENIDÆ are characterized by the absence of teeth in both jaws, which are covered by a horny sheath. The body is long and eel-shaped; the fore limbs alone are present; the external gills are well developed.

The family is represented by two genera, each with a single species, namely, *Siren* and *Pseudobranchus*, both of the South-Eastern United States; in the former genus the digits are four in number, in the latter, only three.

The SIREN, *S. lacertina*, which is not unlike *Amphiuma* in appearance, lives in shallow ponds and marshes, where it grows to a length of four feet. In spite of its long external gills the animal frequently leaves the water for short periods.

CHAPTER III

APODA—LIMBLESS BATRACHIANS

THE Apoda are worm-like, burrowing creatures, entirely devoid of limbs, or even their internal rudiments, without or with only the rudiment of a tail. The entire body, which is generally perfectly cylindrical, sometimes slightly compressed or depressed, is marked with numerous ring-like grooves.

In some forms scales are found embedded under the skin, which is smooth and has always a naked appearance. The eyes are minute and covered, in most species, with skin, some species being completely blind.

The Apoda possess neither ear-opening nor tympanum. They are all provided with a short, retractile, cone-shaped tentacle, a sensory organ, situated between the eye and the tip of the snout.

The members of this order inhabit Tropical Africa and America, South-Eastern Asia, and the Seychelles; they are most frequently found under damp earth, and consequently most abundant in swampy districts. Some forms lay eggs, while others bring forth their young alive.

The complete development of *Icthyophis glutinosus*, of Ceylon and South-Eastern Asia, has been studied by the cousins Sarasin. The eggs, which are of very large size and which form a rosary-like string, are deposited in holes

in the earth, on the banks of small rivers or ponds. Soon after being laid they adhere together, forming a mass round which the female coils herself for their protection. The gelatinous envelope of the egg is thick and tough, and the embryos, which are provided with extremely long external gills, are only released at an advanced stage of their development, and only after the external gills have been lost, the larva being then provided

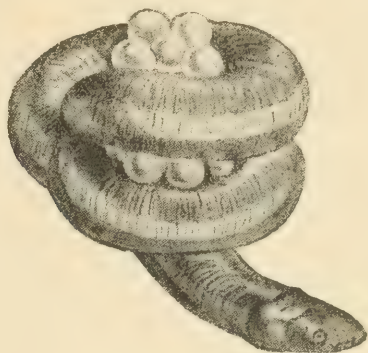


FIG. 25.—*Ichthyophis glutinosus*, female with eggs.

(After Sarasin.)

with an opening on each side, behind the head, the *spiraculum*. During their aquatic life the eyes are well developed; the tail, although short, is crested above and below, and the head resembles that of a Urodele.

The development of *Hypogeophis*, of the Seychelles, corresponds to that of *Ichthyophis*; the larvæ, however, do not go to the water, the young leaving the egg in the perfect form, leading, as soon as released, the burrowing existence of their parents.

Typhlonectes and *Siphonops*, of South America, and *Dermophis thomensis*, of West Africa, do not lay eggs, the

young being born alive, in the perfect form in the two American species, at an advanced stage in the African.

The Apoda are represented by only a single family, the *Cæciliidæ*, of which there are twenty-two genera and about fifty species. The characters on which the genera are based reside in the presence or absence of the scales, which are embedded under the skin, the presence or absence of eyes, the form of the tentacle, and the structure of the skull.

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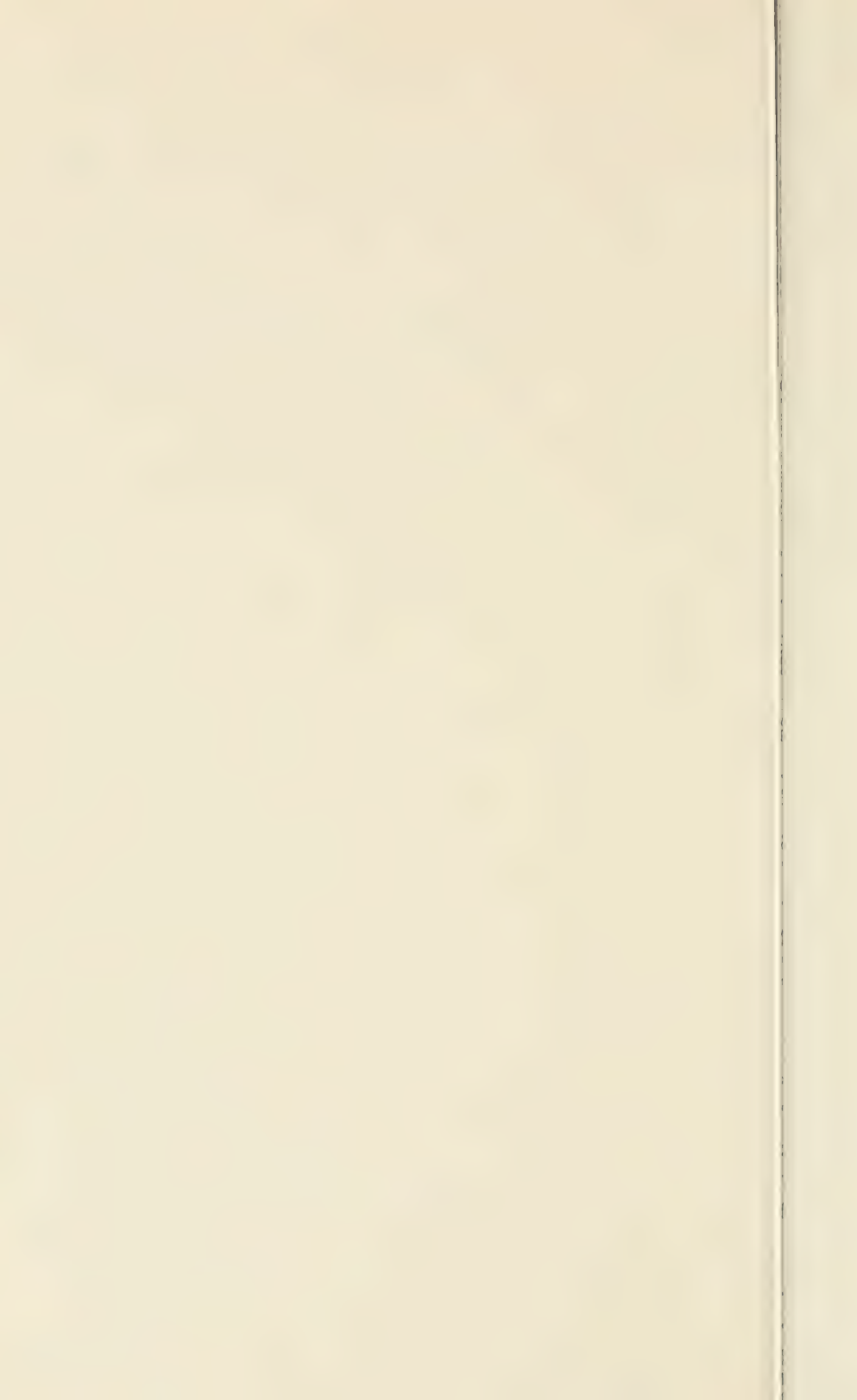
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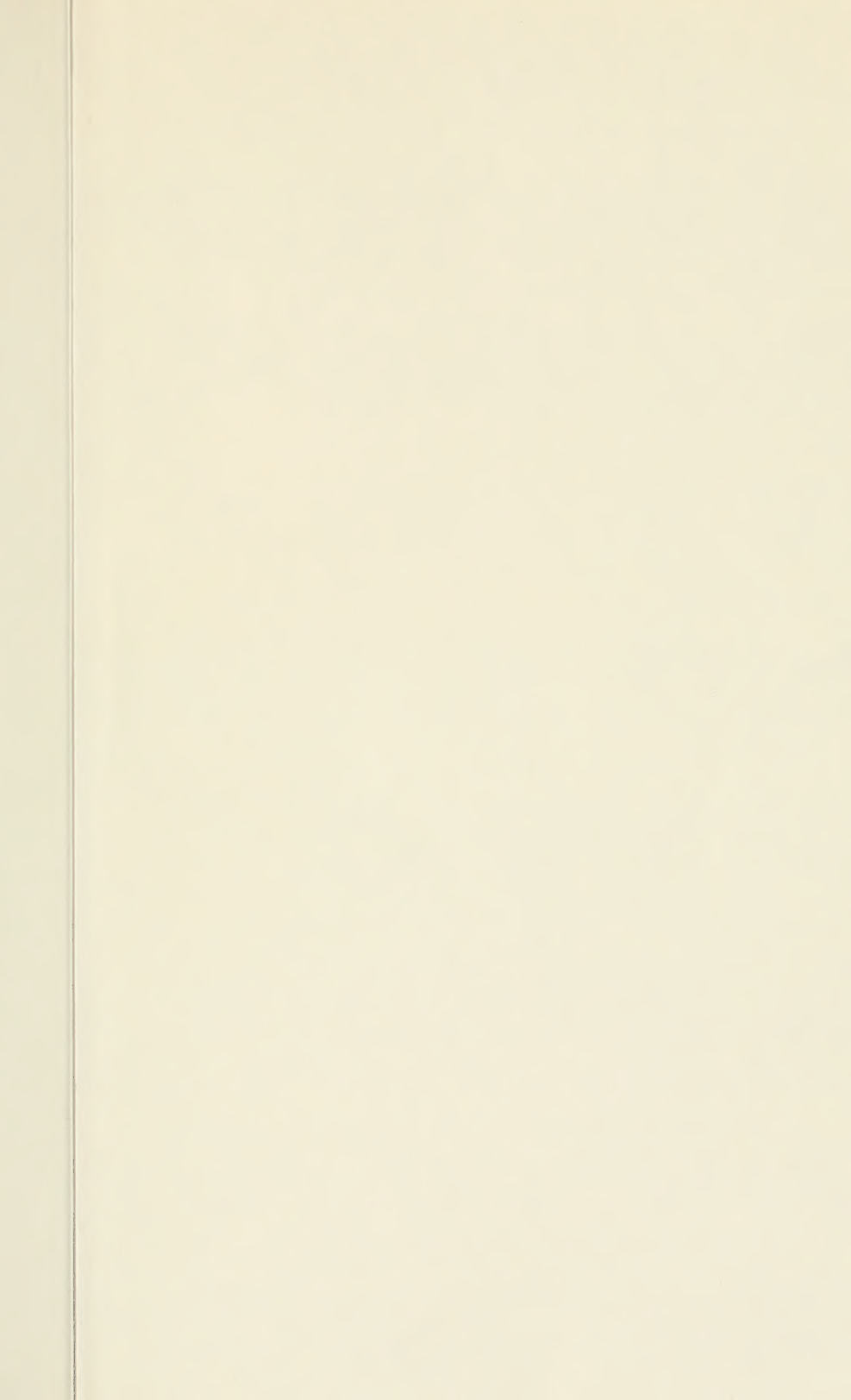
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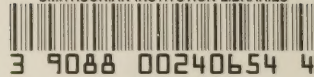
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